EPTD DISCUSSION PAPER NO. 101

IMPACTS OF PROGRAMS AND ORGANIZATIONS ON THE ADOPTION OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES IN UGANDA

Pamela Jagger and John Pender

Environment and Production Technology Division

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

March 2003

ACKNOWLEDGMENTS

The authors gratefully acknowledge the financial support of the German Federal Ministry of Technical Cooperation, the Norwegian Ministry of Foreign Affairs, and the U.S. Agency for International Development for this research. We are also grateful to the Makerere University Faculty of Agriculture, the National Agricultural Research Organization of Uganda, the Agricultural Policy Secretariat of Uganda, and the Center for Development Research at the University of Bonn, which are collaborating in this research project; to the policy makers, representatives of government and non-government organizations, international research organizations and other stakeholders who participated in the workshops for this project and provided valuable ideas and feedback on the research findings; and especially to the many farmers and other community representatives who graciously agreed to participate in the study. Any errors or omissions are solely the responsibility of the authors.

ABSTRACT

The government of Uganda is currently decentralizing many of its services including those directly related to agriculture and the environment. Non-government organizations (NGOs) and community-based organizations (CBOs) are being asked to take the lead in the provision of government services such as agricultural extension during the transition to demand driven fee-for-service. This paper explores the role of government programs, NGOs and CBOs in the adoption of land management technologies.

We find that government programs were better distributed throughout Uganda and were more likely to operate in poorer areas than NGOs and CBOs. This raises the question of whether or not incentives should be provided for NGOs and CBOs to locate or evolve in less-favored areas. Our analysis of household level involvement in organizations between 1990 and 2000 indicates that female-headed households, households with higher proportions of women, and households with higher levels of natural resource dependence were more likely than other households to be involved in organizations whose main focus was not agriculture or the environment. We also found that social capital is an important determinant of organizational participation.

The results of our analysis indicate that the presence of an agriculture or environment focused program or organization at the community level had a negative effect on the adoption of animal manuring and a positive affect on the adoption of pesticides. This suggests that spillover effects of programs and organizations may be greater for technologies that have short-term benefits, and which require some degree of coordination to be most effective. Household level involvement in an agriculture or environment focused organization had a positive effect on the adoption of inorganic fertilizer and mulching. Adoption of land management technologies such as manuring that yield longer-term benefits apparently do not spill over to non-participants in local programs and organizations. Thus, direct involvement of households in programs and organizations that promote such technologies may be necessary to ensure technology diffusion throughout communities.

This information may be taken as an indicator of the effectiveness or impact of agriculture and environment focused organizations in Uganda, and should be considered in the broader context of the government devolution of services to NGOs and CBOs. Our findings indicate that careful consideration needs to be given to the potential for NGOs and CBOs to fulfill the roles traditionally filled by government programs in the context of land management. The limited impact of agriculture and environment focused organizations on technology adoption is discouraging – though may be linked to the limited profitability of technology adoption in the short-run.

Keywords: community-based organization, decentralization, land management, non-government organization, sustainable development, Uganda

TABLE OF CONTENTS

IMPACTS OF PROGRAMS AND ORGANIZATIONS ON THE ADOPTION OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES IN UGANDA

Pamela Jagger[1] and John Pender[2]

1. INTRODUCTION

Governments are devolving service and infrastructure provision, regulatory authority, and decision making in many developing countries. Market reforms and structural adjustment policies devolve the provision of services and infrastructure to non-governmental organizations (NGOs), community-based organizations (CBOs), and the private sector (Farrington and Bebbington 1993; Pender and Scherr 2002; and Uphoff 1993). The transition from the provision of extension services, input supply, rural credit delivery, regulation, and other aspects of natural resource management from centralized governments to alternative institutions may have significant implications for the capacity of smallholders to sustainably manage their resources. As land degradation is a persistent and worsening problem in many developing countries, particular attention will need to be given to facilitating decentralized institutions that promote increased adoption of sustainable agricultural practices. Sustainable land management is central to rural development and generally leads to increased incomes, food security, and decreased poverty.

Uganda presents an interesting opportunity to analyze the challenges and opportunities for institutional change in the face of government devolution and increasing land degradation. The government of Uganda is presently decentralizing many of its

[1] Pamela Jagger is a Research Analyst in the Environment and Production Technology Division at the International Food Policy Research Institute
[2] John Pender is a Senior Research Fellow in the Environment and Production Technology Division at the International Food Policy Research Institute

services, including those that are directly related to agriculture and the environment. There is considerable evidence that land degradation in Uganda's rural areas has been increasing and will continue to do so. Average annual soil nutrient losses of more than 70 kilograms of nitrogen, phosphorus, and potassium (NPK) are among the highest rates of depletion in sub-Saharan Africa (Stoorvogel and Smaling 1990). Analysis of community perceptions about changes in natural resource conditions since 1990 indicates that the availability and quality of cropland, grazing land, forests, and woodland are perceived to be decreasing throughout the country. Soil fertility is perceived to have significantly deteriorated, and soil moisture-holding capacity and erosion problems are worsening. Natural water sources and the biodiversity of plants and animals are also perceived to be deteriorating in availability and quality (Pender et al. 2001).

Land management policy in Uganda is currently being shaped by the Plan for the Modernization of Agriculture (PMA), the Poverty Eradication Action Plan (PEAP), and the Decentralization of Public Service Reform Plan. One of the main goals of the PMA is that all activities related to agricultural production, agricultural processing, trading, the input supply and the import/export of agricultural produce will eventually be carried out by the private sector (MAAIF 1999). However, given lags in the time it takes for effective private sector intervention, non-government organizations and community-based organizations are being asked to take the lead in providing these services in the medium-term, with the goal of privatization of services by 2020.

The primary objective of this discussion paper is to characterize programs and organizations in Uganda and to determine whether community and/or household involvement in programs and organizations is influencing household level adoption of

land management technologies. If community and/or household involvement in programs and organizations have an observable impact on the adoption of sustainable land management technologies, then there is a case for providing incentives to encourage their development and sustainability. In particular, less-favored areas that have traditionally been serviced by few programs and organizations may be key areas for the promotion of organizations.

This paper is organized as follows: the next section provides a brief historical review of the roles of programs and organizations in Uganda from the mid 1950s to present. The third section describes the study area and survey. Using survey data we characterize programs and organizations that operated in rural Uganda between 1990 and 1999. The fourth section provides a conceptual framework and econometric analysis of the determinants of programs and organizations and their impact on the adoption of land management technologies. We conclude with a discussion of policy implications emanating from the study.

2. NGOS AND CBOS IN UGANDA – A BRIEF HISTORY

Organizations including indigenous NGOs, urban associations, trade unions, and cooperative societies such as the Ugandan African Farmer's Association enjoyed relative independence under the colonial government (Mamdami 1993). However, the newly independent government of Milton Obote was quick to impose government regulation of cooperatives (Cooperative Societies Act of 1963), and the regulation of trade unions (1970 Trade Union Act), which resulted in the formulation of a single state run cooperative and a single trade union in the early 1960s (Hyden 1983). Although a 1973

decree restored the autonomy of unions, organizations were unable to function effectively under Idi Amin's regime.

Government programs dealing with agriculture and/or sustainable land management also failed under Obote and Amin. Agricultural research and extension services collapsed in the late 1970s (ISNAR 1988). Smallholder cash crop production was seriously affected. Food crops that could be sold in local or regional markets replaced cotton production, and coffee survived due to the smuggling of produce across borders by an evolving network of private traders (Brett 1991).

Throughout the 1970s and 1980s only a few international NGOs functioned in the country providing disaster and relief services, and indigenous NGOs had very limited reach (Dicklitch 1998). During this time the most outspoken rural voices were churches, who in addition to acting as human rights watchdogs, provided assistance to meet basic social needs. Churches also became increasingly involved in the provision of basic health and education services as the economic collapse of state services worsened in the early 1980s (Nabuguzi 1995).

When Musuveni took over leadership of the country in the mid-1980s, rural infrastructure was in serious disrepair (Howes 1997; Brett 1991; 1994). However, economic, social, and political change was rapid under Musuveni's National Resistance Movement. The implementation of structural adjustment programs that emphasized market rather than state delivery of services was the focus of the new government. In addition, donors, self-help organizations, NGOs and others arrived to assist with rebuilding the country (Dicklitch 1998). Uganda's relative success with structural adjustment led to growth in real agricultural GDP of 4 percent per annum between 1987

and 1997, while real manufacturing GDP averaged 16 percent growth (Belshaw, Lawrence and Hubbard 1999).[3]

In the late 1980s, during the first structural adjustment phase, the National Agricultural Research Organization (NARO) was formed. In addition to a strong focus on agricultural research, NARO took on the responsibility of organizing and training extension personnel to service the rural areas (ISNAR 1988). Land distribution and tenure rights were also significant issues. Throughout the Amin years the elite appropriated large tracts of land and evicted occupants without recourse, resulting in common lands and forest reserves being invaded by squatters (Brett 1991). The new government assumed responsibility for monitoring and protecting common land and protected areas as foreign NGOs, indigenous NGOs, community organizations, and cooperatives reorganized.

The current framework of decentralization is providing an enabling enviroment for NGO activities. The National Agricultural Advisory Service (NAADS) is an example of one of the five central initiatives of the PMA that will rely on NGOs to provide demand-driven fee-for-service extension services to smallholders within three to five years, and until the service provision can be fully privatized. Proposed requirements to align government policy with NGO mandates will make the transition to fee-for-service extension smoother – but may also limit the previously independent scope of NGOs focused on natural resource management.

Community-based organizations are much less formally organized in Uganda and generally grow out of an identified need within the community. CBOs are not registered

[3] Growth rates can be compared with real average annual rates of growth of 4 percent for agriculture and 8 percent for manufacturing in the late 1960s and early 1970s (Belshaw, Lawrence and Hubbard 1999).

unless their activities go beyond the needs and services of the immediate community. Given the absence of a registration system or any formal requirements at the district level to document their presence, information on CBOs is scarce and their numbers difficult to estimate. CBOs have the potential to reach policy makers by communicating their message through the established Local Council (LC) system, or by directly lobbying their Member of Parliament.

3. RESEARCH METHOD

We investigate the presence and roles of programs and organizations and their influence on the adoption of sustainable land management technologies using data collected from a series of surveys (community, village, and household level), conducted between 1999 and 2001. Community level characterization of programs and organizations is based on a survey of 107 LC1s (local councils comprised of one or a few villages), and villages from throughout most of Uganda conducted in 1999/2000.[4] A random sample of LC1s was stratified by agricultural potential, market access and population density.[5]

Agricultural potential classifications are based upon average length of growing period, average rainfall, maximum annual temperature, and altitude. Six zones were identified, the low and medium potential unimodal rainfall areas at moderate elevations (much of northeastern Uganda, and parts of northern and eastern Uganda), the low potential bimodal rainfall area at moderate elevations (lower elevations areas of southwestern Uganda), the medium potential bimodal rainfall area at moderate elevation

[4] The original sampling frame excluded most of northern Uganda. Community, village, household and plot level surveys are currently being conducted in this region.
[5] Due to security threats in the western part of the country during the time of the survey, some LC1's drawn in the random sample were dropped.

(most of central and parts of western Uganda), the high potential bimodal rainfall areas (Lake Victoria crescent), the high potential bimodal rainfall areas of the southwest highlands, and the high potential eastern highlands (Sserunkuuma et al.2001). Market access was classified using the measure of potential market integration estimated by Wood et al. (1999), which is a measure of travel time from any location to the nearest five towns or cities, weighted by the population of the towns or cities. Areas with high market access include most of the Lake Victoria region, the southwest and eastern highlands, and parts of the north and west that are close to major roads or towns (Sserunkuuma et al. 2001). Population density was classified based upon parish level rural population density in 1991, where greater than 100 persons per square kilometer is classified as a high population density region (Ibid). Both highland (elevation greater than 1500 m.a.s.l.) and lowland sites are represented in the sample.

One village was randomly selected from within each LC1. Respondents were groups of approximately eight to fifteen LC1 or village members selected to represent different ages, occupations, and genders. Data on programs and organizations encompassed all programs and organizations present at the LC1 level and below.

Household surveys were conducted during 2000-2001 with four or five randomly selected households from within each LC1. The household heads as well as other members of the household actively engaged in household decision-making were interviewed. Data on household level involvement with all types of programs and organizations were collected. Information on sustainable land management technologies used by the household was also collected in this survey. We have a sample size of 451 households.

CHARACTERIZING PROGRAMS AND ORGANIZATIONS IN RURAL UGANDA

Types of programs and organizations

Programs are characterized as institutions associated with the government of Uganda. Programs are unique in their ability to evoke the authority of the state to levy taxes, and prohibit certain behaviors by implementing and enforcing laws (Uphoff 1998). We divided organizations into two categories. Community-based organizations are those that evolve and are administered, financed, and managed at the local level. Community-based organizations are not registered with the government. Non-government organizations include both international and indigenous organizations established to provide services to communities or districts. They are autonomous and are required to conform to the government's regulatory requirements regarding registration and reporting.

We examined community level presence of programs and organizations between 1990 and 1999 focusing on the number of each type of program or organization present in each community. We also considered household level involvement in programs and organizations, where household involvement was defined as any member of the household participating in the program or organization between 1990 and 2000 (Table 1). At the community level NGOs were the most common type of organization with an average of almost one NGO per LC1. The bimodal high and low rainfall zones had the highest average number of NGOs present per LC1. These areas, including the Lake Victoria crescent and the southwest cattle corridor have good access to roads and markets, which may influence why NGOs operate in these regions. The lowest average numbers of NGOs per LC1 were found in the medium potential bimodal rainfall and eastern highland zones.

The average number of government programs and community-based organizations present in sample communities was approximately equal. The highest average number of government programs was found in the bimodal high potential areas, which are close to the urban areas of Kampala and Jinja. The unimodal areas in the north and east had the second highest number of government organizations. Conversely, the southwest and eastern highlands had very few government programs. Community based organizations were most common in the southwest highlands, in sharp contrast to the eastern highlands and low potential unimodal areas, where there were few or no CBOs.

Table 1 – Average number of programs and organizations per LC1 1990-1999, and household involvement in programs and organizations 1990-2000[A,B]

PROGRAM OR ORGANIZATION	AVERAGE	AGRICULTURAL POTENTIAL						MARKET ACCESS		POPULATION DENSITY	
		Unimodal	Bimodal low	Bimodal medium	Bimodal high	Southwest highlands	Eastern highlands	Low	High	Low	High
Community Presence (n=107)											
		Number of Programs or Organizations per Community									
Government program	0.64	0.74	0.36	0.39	1.10	0.17	0.30	0.58	0.66	0.60	0.66
	(0.11)	(0.17)	(0.15)	(0.11)	(0.32)	(0.10)	(0.22)	(0.11)	(0.15)	(0.11)	(0.16)
NGO	0.99	1.10	1.41	0.50	1.44	0.79	0.55	0.64	1.13	0.78	1.10
	(0.11)	(0.40)	(0.37)	(0.14)	(0.22)	(0.29)	(0.25)	(0.14)	(0.14)	(0.13)	(0.15)
CBO	0.62	0.07	0.85	0.33	0.52	2.13	0	0.25	0.78	0.48	0.70
	(0.08)	(0.07)	(0.36)	(0.14)	(0.15)	(0.35)		(0.12)	(0.11)	(0.14)	(0.12)
Household Involvement (n=451)											
		Percent of Households									
Government program	0.71	0	0	0	1.2	1.7	0	0	1.0	6.9	18.5
	(0.41)				(0.1)	(1.7)			(1.0)	(2.7)	(3.5)
NGO	14.9	20.3	3.4	6.2	21.1	3.1	17.0	8.8	17.0	76.9	84.0
	(2.6)	(9.5)	(3.4)	(2.4)	(4.6)	(1.9)	(9.7)	(2.9)	(3.3)	(3.1)	(2.9)
CBO	81.8	74.2	75.1	76.1	86.2	96.6	2.5	70.7	85.7	6.9	18.5
	(2.2)	(9.6)	(6.7)	(4.0)	(3.1)	(2.4)	(11.0)	(4.2)	(2.6)	(2.7)	(3.5)

A. Means and errors are corrected for sampling stratification and sampling weights.
B. Values in parentheses represent standard errors.

We found higher numbers of NGOs in areas with good market access, and in areas with high population density. The number of government programs did not vary significantly across low and high market access areas, or areas of low and high population density. Like NGOs, community-based organizations were more common in areas with good market access and high population densities. Households reported being primarily involved in NGOs and CBOs. Low reported levels of involvement in government programs might be due to the fact that most government programs are infrastructure related. Though these programs may have required labor inputs from households, the households themselves were unlikely to perceive this as "involvement" in the program.

Approximately 15 percent of households reported having at least one member involved in a non-government organization at some time between 1990 and 2000. These organizations include both externally organized (for example, CARE, African Highlands Initiative, World Vision etc.), and locally organized groups that were registered as NGOs. The unimodal and bimodal highland areas had the highest levels of household involvement in NGOs with approximately 20 percent of households reporting involvement by at least one household member. The eastern highlands also had a relatively high level of involvement in NGOs, which contrasts with very low levels of involvement in community-based organizations in this region. Over 80 percent of households in our sample were involved in CBOs between 1990 and 2000, with almost all households in the southwest highlands being involved in a CBO. The proportion of households involved in NGOs and CBOs was higher in more densely populated areas and

areas with good market access. These findings are consistent with community level data on the presence of programs and organizations.

The general picture of institutional presence in the sample communities is that government programs, NGOs and CBOs were well represented in the bimodal high potential areas close to urban centers. Government programs, NGOs and CBOS were poorly represented in the highland regions with the exception of CBOs in the southwest highlands. The absence of significant differences in the presence of government programs between high vs. low market access areas, or areas of varying population density indicates that government programs were relatively unbiased with respect to investment in less-favored areas. Higher average numbers of NGOs in areas with good market access and high population densities may be due to the lower transactions costs of operating in these areas and contacting potential participants, higher potential economic returns to organizational activities, and the potential for impacting a greater number of people. Our finding that CBOs were more common in areas with good market access may be explained by better access to information about how to organize and the potential benefits of organization, as well as ease of organizing when community members are located closer together.

MAIN FOCUS OF PROGRAMS AND ORGANIZATIONS

Programs and organizations in rural Uganda operate in a wide variety of sectors. We consider both the proximate and underlying causes of land degradation to categorize programs and organizations, and to identify their potential relationships to sustainable land management. The proximate causes of land degradation include natural factors such as soil type and climate fluctuation, and unsustainable farming practices such as

decreased fallow periods and the cultivation of fragile lands. We hypothesize that programs and organizations focused on agriculture or environment related topics such as tree planting, or the distribution of agricultural inputs are likely to have a direct effect on the adoption of land management technologies (Table 2). Programs and organizations also focus on issues such as population pressure, poverty, lack of infrastructure and services, lack of access to credit and the provision of social services. Though the goal of these types of programs and organizations is not to address the issue of land degradation, they may have an indirect effect on the adoption of land management technologies.

In approximately half of the LC1s in our survey at least one program or organization focused on agriculture or environment related issues during the 1990s (Table 3). Agriculture and environment programs and organizations were most common in the high potential bimodal rainfall areas. Surprisingly, there were very low numbers of these programs and organizations in the highland areas where land degradation is a particularly serious problem, and in the medium potential bimodal rainfall areas. Approximately 30 percent of the households in our survey reported involvement in an agriculture or environment focused organization. Above average levels of involvement were found in the unimodal rainfall areas (42 percent) and in the bimodal high rainfall areas (34 percent). Given the relatively limited community-level presence of such organizations in the unimodal zone, household participation in the unimodal areas was higher than expected.

Of the programs and organizations focused on topics other than agriculture and the environment, community respondents cited very few with a main focus on credit or reducing population pressure. A high proportion of programs and organizations deal with

Table 2 – Main focus of programs and organizations in relation to the proximate and underlying causes of land degradation

CAUSE OF LAND DEGRADATION	DESCRIPTION OF CAUSE	RELATIONSHIP TO LAND MANAGEMENT	MAIN FOCUS OF PROGRAMS OR ORGANIZATIONS (ACTIVITIES)
Proximate Causes of Land Degradation			
Natural factors	Soil type and climate variability	Direct	*Agriculture and veterinary services/extension* (training and sensitization, supply of inputs, stocking and restocking livestock, credit for input purchase, promoting adoption of new technologies, marketing of agro-products) *Environment* (afforestation, promoting soil and water conservation, energy conservation and research)
Unsustainable farming practices	Decreased fallows and cultivation of fragile lands	Direct	
Underlying Causes of Land Degradation			
Population pressure	Increased land pressure due to decreased fallows and partitioning of farmland, increased food demand	Indirect	*Women's empowerment and emancipation* (increase household decision making power and community participation) *Health* (sex education and family planning)
Lack of infrastructure and services	Poor infrastructure can slow price signals and reduce access to agricultural inputs Lack of adequate education, health, water services etc. can reduce labor productivity	Indirect	*Education* (construction and maintenance of schools, provision of scholastic materials) *Health* (construction and maintenance of health facilities, provision of medical supplies and pharmaceuticals) *Water and sanitation* (improved access to water for drinking and irrigation) *General infrastructure* (investment in roads)
Lack of credit	Providing credit may affect the use/adoption of inputs and sustainable land management technologies	Indirect	*Credit*
Poverty	May lead to short term planning horizons that inhibit households from investing in land management	Indirect	*Income generation* (job training, entrepreneurial skills) *Poverty eradication* *Social development* *Social assistance to the disadvantaged*
Lack of community services	Generally meet short to medium term community needs for assistance	Very indirect	*Mutual support* *Funeral arrangements* *Youth programs*

infrastructure and services (including those focused on education, health, water and general infrastructure) The highest average number of such programs and organizations was in the southwest highlands, which may explain general improvements in health and education in this region between 1990 and 1999 (Pender et al. 2001).

Household involvement in organizations focused on credit or community service was most common. This finding contradicts community level data, which show such organizations to be relatively rare in many areas. It is possible that community members did not perceive locally organized credit and savings groups as "organizations" when responding to the community level survey. Alternatively it could be that the provision of credit is the function that many households identify NGOs and CBOs with, whereas community leaders may not have identified credit as the organization's primary focus. The highest proportion of household level involvement in community service focused organizations was in the southwest highlands. The bimodal high rainfall and bimodal low rainfall areas also had above average household involvement in community service focused organizations. In general our findings with respect to household level involvement in infrastructure and service or poverty reduction focused organizations were consistent with community level data on the presence of programs and organizations.[6]

Higher average numbers of agriculture and environment programs were found in LC1s with good market access or high population density. Households in areas with good market access also had higher rates of participation in agriculture and environment focused programs and organizations. Both poverty alleviation and community service

[6] As with the community data – we encountered some households that reported had no involvement in organizations (20 percent).

Table 3 – Average number of programs/organizations per LC1 1990-1999, household involvement in programs and organizations 1990-2000, by Sector[A,B]

MAIN FOCUS OF PROGRAM OR ORGANIZATION	AVERAGE	AGRICULTURAL POTENTIAL						MARKET ACCESS		POPULATION DENSITY	
		Unimodal	Bimodal low	Bimodal medium	Bimodal high	Southwest highlands	Eastern highlands	Low	High	Low	High
Community Presence (n=107)		**Number of Programs and Organizations per Community**									
Agriculture/Environment	0.44	0.32	0.57	0.14	0.87	0.13	0.25	0.17	0.55	0.26	0.53
	(0.07)	(0.19)	0.23)	(0.06)	(0.19)	(0.10)	(0.21)	(0.10)	(0.10)	(0.10)	(0.10)
Population	0.09	0.15	0.08	0	0.17	0.09	0.25	0.02	0.13	0.05	0.12
	(0.03)	(0.08)	(0.08)	N/A	(0.08)	(0.09)	(0.21)	(0.02)	(0.05)	(0.03)	(0.05)
Infrastructure	0.74	0.74	0.76	0.76	0.58	0.52	0.61	0.77	0.71	0.67	0.75
and services	(0.10)	(0.10)	(0.33)	(0.25)	(0.17)	(0.22)	(0.29)	(0.18)	(0.11)	(0.16)	(0.12)
Credit	0.08	0.07	0.07	0	0.18	0.09	0	0.03	0.11	0.07	0.09
	(0.04)	(0.07)	(0.07)	N/A	(0.11)	(0.09)	N/A	(0.02)	(0.06)	(0.04)	(0.06)
Poverty	0.76	0.68	0.97	0.49	0.82	1.35	0.09	0.51	0.86	0.74	0.76
	(0.12	(0.27)	(0.33)	(0.19)	(0.26)	(0.3)	(0.05)	(0.19)	(0.15)	(0.18)	(0.15)
Community service	0.18	0	0.17	0.04	0.12	0.91	0	0.04	0.25	0.08	0.24
	(0.03)	N/A	(0.13)	(0.04)	(0.07)	(0.14)	N/A	(0.03)	(0.05)	(0.04)	(0.05)
Household Involvement (n=451)		**Percentage of Households**									
Agriculture/Environment	29.8	41.5	11.0	23.1	34.2	25.0	27.4	19.7	33.4	26.6	31.3
	(3.4)	(9.6)	(6.5)	(4.8)	(6.2)	(6.3)	(10.7)	(4.5)	(4.3)	(3.6)	(4.7)
Population	0	0	0	0	0	0	0	0	0	0	0
Infrastructure	14.9	28.9	8.9	12.1	12.0	23.9	13.6	12.2	15.9	11.3	16.6
and services	(2.3)	(10.1)	(4.4)	(3.8)	(3.4)	(5.8)	(9.0)	(3.9)	(2.8)	(3.7)	(2.9
Credit	41.8	32.3	62.3	34.4	37.9	82.1	22.6	35.9	43.9	41.2	42.1
	(3.1)	(5.8)	(8.0)	(4.9)	(5.7)	(5.3)	(11.3)	(5.0)	(3.7)	(4.9)	(3.8)
Poverty	14.0	9.9	13.6	11.6	13.5	23.5	27.6	10.8	15.2	12.5	14.7
	(2.6)	(5.0)	(7.0)	(3.8)	(4.6)	(7.3)	(11.3)	(3.7)	(3.2)	(4.1)	(3.2)
Community service	48.6	27.7	49.1	34.4	56.2	83.4	23.4	42.5	50.8	38.1	53.4
	(2.8)	(9.6)	(9.1)	(5.0)	(4.3)	(6.1)	(9.9)	(5.3)	(3.2)	(4.8)	(3.4)
Labor Exchange	12.8	8.2	15.8	14.7	11.2	25.9	1.3	14.4	4.0	17.8	10.5
	(2.1)	(4.8)	(7.1)	(4.5)	(3.4)	(6.8)	(1.3)	(12.2)	(2.4)	(4.3)	(2.3)
Miscellaneous	12.2	11.1	4.7	8.7	16.5	9.6	4.2	9.5	13.2	9.9	13.3
	(2.6)	(9.1)	(4.7)	(3.6)	(4.6)	(3.4)	(3.8)	(3.4)	(3.3)	(3.4)	(3.4)

A. Means and errors are corrected for sampling stratification and sampling weights.
B. Values in parentheses represent standard errors.

focused programs and organizations were more common in high market access areas. Household involvement in credit programs and organizations did not differ significantly with market access or population density. Approximately 50 percent of households in areas with good market access and higher population densities were involved in community service focused organizations. [7]

To investigate the effects of programs and organizations on farmers' adoption of land management technologies, we consider household use of inorganic fertilizer, animal manure, incorporating crop residues, mulching, and pesticides (Table 4). A higher proportion of households adopted pesticides when there was an agriculture or environment focused program or organization in the LC1. Rates of adoption of inorganic fertilizer, animal manure and applying crop residues were only slightly lower for these communities. Having other types of programs or organizations present in the LC1 appears to have little influence on whether technologies are adopted. Rates of technology adoption were higher in all cases where households were involved in agriculture or environment focused organizations, most significantly the adoption of pesticides, mulching, and applying organic matter. Household involvement in other types of programs or organizations (i.e. infrastructure, credit, poverty alleviation and community service) also had a positive association with the adoption of all land management technologies considered, though to a lesser extent than household involvement in agriculture and environment related programs and organizations. However, these associations may be due to other factors such as differences in agricultural potential or market access, than to participation in these programs and

[7] In our sample of 107 LC1s, approximately 21 percent of communities did not report having any programs or organizations between 1990 and 1999. This finding might be due to miscommunication during the administration of the questionnaire.

organizations. The analysis in the following section further explores the potential effects of organizational presence or household level involvement in an organization on the adoption of sustainable land management technologies, controlling for other factors.

Table 4 – Household level adoption of selected land management technologies in 2000, all households, households in communities with program or organizations present, and households with involvement in organizations (percent) [A,B]

TECHNOLOGY	ALL HOUSEHOLDS	AG/ENV PROG/ORG IN LC1	ORG FOCUSED ON INDIRECT CAUSES OF LAND DEG. IN LC1	INVOLVED IN AG/ENV FOCUSED ORG	INVOLVED IN ORG FOCUSED ON INDIRECT CAUSES OF LAND DEG.
	(N=446)	(N=147)	(N=323)	(N=112)	(N=318)
Applying inorganic fertilizer	10.0 (2.0)	9.1 (3.7)	7.6 (2.2)	17.9 (5.5)	10.9 (2.6)
Applying pesticides	23.4 (2.9)	29.9 (5.9)	21.5 (3.4)	25.0 (5.8)	26.3 (3.6)
Applying crop residue	17.6 (2.4)	14.3 (3.6)	19.0 (2.9)	19.4 (5.9)	17.8 (5.7)
Mulching and applying organic matter	20.4 (2.6)	21.2 (4.9)	20.7 (3.1)	28.1 (6.6)	21.6 (3.2)
Applying animal manure	23.0 (2.8)	22.1 (4.8)	22.6 (3.3)	25.5 (6.0)	24.3 (3.5)

A. Means and errors are corrected for sampling stratification and sampling weights.
B. Values in parentheses represent standard errors.

4. CONCEPTUAL FRAMEWORK FOR ECONOMETRIC ANALYSIS

We propose six possible outcomes related to the impact of a program or organization on the adoption of land management technologies (Figure 1). We first consider whether the program or organization is present in the community. Our hypothesis is that households located in communities with agriculture or environment focused programs or organizations are more likely to adopt land management technologies, even if not directly involved in such organizations, due to knowledge spillover effects.

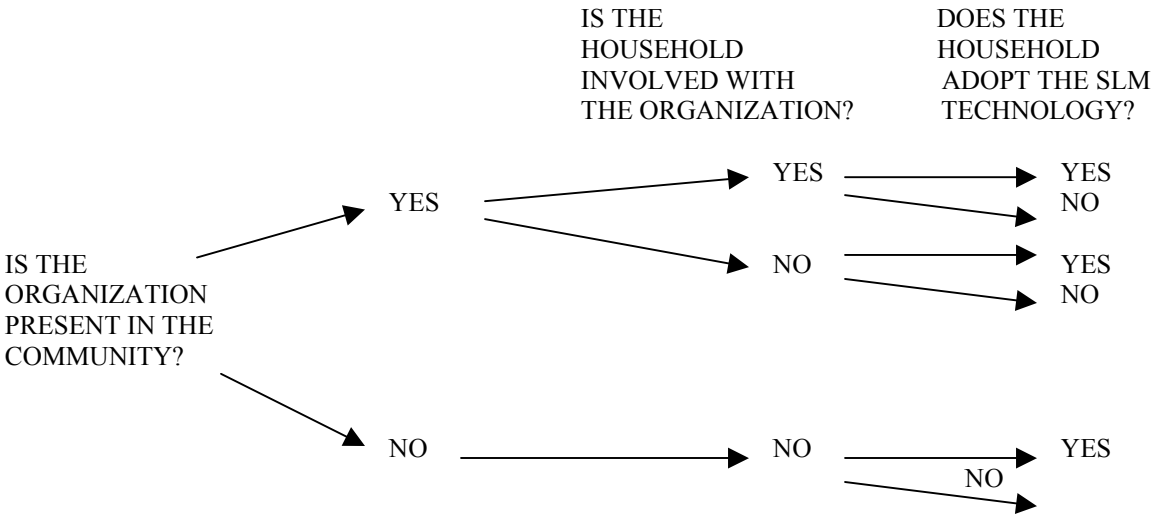

Figure 1: Organizational Presence and the Potential for Land Management Technology Adoption

We also expect that communities that have programs or organizations focused on credit provision, poverty reduction, and other areas that generally lead to improved incomes and welfare may be more likely to adopt land management technologies. However, this linkage will be indirect.

The second decision deals with whether the household participates in the program or organization. This decision is determined by the organization if they are targeting households that fit specific program criteria, as well as the household. We explore the determinants of household level involvement in programs and organizations econometrically. As with the presence of a program or organization in a community, we hypothesize that households directly involved with an organization focused on agriculture or environment related issues are more likely to adopt land management technologies. We also expect that household level involvement in organizations focused on poverty reduction, reducing population pressure etc. may indirectly affect technology adoption. Involvement in these types of programs or organizations may lead to medium to long-run changes in the ability or willingness of smallholders to adopt land management technologies. However, these longer-term effects may be difficult to discern from the limited time period our data consider.

The third decision is whether the household will adopt the land management technology. We estimate a two stage probit model to determine the effect of the presence of a program or organization in a community and household level involvement in the program or organization on the adoption of land management technologies.

When there is no program or organization in the community there are two possible outcomes in our model: the technology is adopted or not adopted by the household. Technology adoption could be due to interactions with government extension officers, farmer innovations, information diffusion through social networks etc. We control for these and other factors in our analysis. The framework we have proposed enables us to investigate the direct effects of programs and organizations on the adoption of land management technologies vs. spillover or

diffusion effects. Spillover or diffusion effects come into play when a program or organization has the ability to affect adoption even among households not directly working with the program or organization through diffusion of information. This is very important to investigate as the ability of technologies to be widely adopted depends largely on ease of diffusion. Some technologies are more likely to diffuse than others. For example, soil and water conservation measures such as Fanyu ju terraces that require substantial labor investments and offer limited returns in the short to medium-term are less likely to diffuse easily than low cost, high return technologies.

EXPLANATORS OF ORGANIZATIONAL PRESENCE

The dependent variables used in our analysis of community level program or organizational presence are, whether there is an agriculture or environment focused program or organization functioning in the community, and whether there is another type of program or organization functioning in the community. Our analysis includes only programs and organizations that started working in communities in 1990 or later.[8] The explanatory variables in our analysis include: agroclimatic zone; market access; population; community level indicators of welfare and wealth estimated for 1990; estimated community level indicators of average education; and access to basic infrastructure and services in 1990.[9] By using explanatory variables based upon estimates of conditions in 1990 we get a sense of the factors that have

[8] We use indicators of general welfare, access to infrastructure and services etc. in 1990 as a benchmark. By examining the programs and organizations present in communities between 1990 and 1999 we are able to determine how factors in 1990 have contributed to the presence of programs and organizations.

[9] We have estimated the proportion of households in the community with each of the welfare, wealth and education indicators by adding or subtracting 10 percent for minor increases/decreases since 1990, and 25 percent for major increases/decreases since 1990 from 1999 proportions.

motivated programs or organizations to locate or evolve in these communities since then (Table 5). [10,11]

[10] Regressions were checked for multicollinearity using variance inflation factor (VIF). The maximum VIF of any of our explanatory variables was 3.63, indicating that multicollinearity is not a problem in our models.
[11] We take the natural log or square root of our explanatory variables when the variable is more normally distributed in this alternative functional form. Doing so generally improved the specification of our model (Mukherjee et al. 1998).

Table 5 – Determinants of program or organization presence by main focus between 1990 and 1999, probit estimation[A]

VARIABLE	PROGAM OR ORGANIZATION FOCUSED ON AGRICULTURE AND/OR THE ENVIRONMENT PRESENT IN LC1	PROGAM OR ORGANIZATION FOCUSED ON OTHER ISSUES PRESENT IN LC1
Agricultural potential (cf. Unimodal)	Coeff.	Coeff.
Bimodal low	0.1102	0.0422
Bimodal medium	-0.2148	-0.3234*
Bimodal high	0.3085	0.2269
Southwest highlands	0.0223	0.1655
Eastern highlands	0.1903	-0.5319*
Market access (0/1 Dummy where High=1)	0.1941	0.1937
Population density (0/1 Dummy where High=1)	0.0313	-0.1767
(ln) Households in LC1 in 1990 (number)	0.0561	0.1290*
Households without adequate food in 1990 (proportion)	-0.0023	0.0346
Households with metal roof in 1990 (proportion)	-0.0041	-0.5448*
Households where adult can read and write 1990 (proportion)	-0.0018	-0.5253
Households with children of secondary school age in school 1990 (prop)	-0.0041	0.5497*
(sqrt) Distance to tarmac road in 1990 (miles)	-0.0724**	0.0593*
(sqrt) Distance to primary school in 1990 (miles)	0.0612	-0.0153
(sqrt) Distance to nearest fuelwood source in 1990 (miles)	-0.0708	-0.1588**
(sqrt) Distance to drinking water source (dry season) in 1990 (miles)	-0.0296	0.0244
(sqrt) Distance to drinking water source (rainy season) in 1990 (miles)	0.0735	0.0152
Number of observations	98	98
Mean of dependent variable	31.6	73.8
Mean predicted probability of program or organization	23.9	80.0
Pseudo R^2	0.2863	0.2773

A. Reported coefficients represent the effect of a unit change in explanatory variable on probability of a program or organization being present at the mean of the data. Coefficients are adjusted for sampling weights and stratification, and are robust to heteroskedasticity. Intercept is not reported.

*, **, *** mean coefficient statistically significant at 10 percent, 5 percent and 1 percent levels respectively.

We have only one significant variable in our model to explain the presence of agriculture and environment focused programs and organizations. The finding that distance to a tarmac road is negative and significant is consistent with our descriptive analysis and indicates that agricultural and environment programs and organizations are associated with good market access. Given that we have few significant variables, our model may be failing to capture some key explanatory variables or these programs may not be well targeted. The model better explains the presence of programs and organizations that may influence the indirect causes of land degradation, though most of our significant variables are only weakly significant. We find that such programs and organizations are less likely to occur in the bimodal medium rainfall and eastern highland regions. We find that programs and organizations are more likely in more populous communities, and also where housing quality (measured by the proportion of people with a metal roof) is lower. We also find that these programs and organizations are more likely in communities where the proportion of school aged children enrolled in secondary school is higher – suggesting a linkage between education and organizational development. Finally, we find that programs and organizations are more likely where access to basic infrastructure is further (in the case of roads), but where access to resources is better (with respect to access to fuelwood). Such programs and organizations appear to focus on less-market connected and more resource abundant communities.

EXPLANATORS OF HOUSEHOLD INVOLVEMENT IN ORGANIZATIONS

Household level characteristics determine whether households will be involved in organizations. The dependent variables for our probit regressions include whether any member of the household was involved in any type of organization, any agriculture or

environment focused organization, or any organization with a focus on topics that might influence the indirect effects of land degradation, between 1990 and 2000 (Table 6). Our explanatory variables include the human, social and physical capital of the household. Indicators of human capital include the education level of the head of household, whether the household head is female, the number of males and females in the household, and the age of the household head. We consider religion and ethnicity of the household head, as well as whether the household head and spouse were born in the village they currently reside in as indicators of social capital.[12] We use estimated acres of land owned or operated by the household in 1990,[13] the number of bulls and cows or heifers owned by the household in 1990, and whether the household owned a radio or bicycle in 1990 as our proxies for physical capital.

[12]Social capital refers to features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit (Putnam 1995). In our model, religion and ethnicity of household head are proxy indicators of social capital, whereas indicators of physical and human capital are actual indicators.

[13] Land owned or operated by the household in 1990 was estimated by calculating the total area of land acquired prior to1990.

Table 6 – Determinants of household involvement in programs and organizations between 1990 and 2000 – all households, probit estimation[A,B]

VARIABLE	HHD INVOLVED ANY IN ORGANIZATION	HHD INVOLVED IN AG/ENV FOCUSED ORGANIZATION	HHD INVOLVED IN OTHER ORGANIZATION
Education level of household head (cf.none)	Coeff.	Coeff.	Coeff.
Some primary or completed primary	-0.0139	0.1204	0.0168
More than primary up to O-levels	0.0019	0.3571**	0.0058
Beyond O-levels	Variable dropped[B]	0.7286***	0.1397
Female household head	0.0856	0.1280	0.1378*
(sqrt) Number of males in household	-0.0573	-0.0515	0.0026
(sqrt) Number of females in household	0.0652*	0.0916	0.0099
(ln) Age of household head	0.0408	0.0925	-0.0236
Non-Christian household head	0.1068	0.0005	0.0950
Baganda	0.1100*	0.0136	0.1180
Banyankore and SW Highland peoples	0.1388***	-0.0231	0.1895***
Northern people (Acholi, Langi etc.)	0.1538**	0.4183	0.1037
Iteso and Kumam	0.0676*	0.0208	0.0565
Eastern peoples (Basoga, Bagisu etc.)	0.1636*	-0.0061	0.1474
Eastern highland peoples	0.0307	-0.1550	0.0136
Household head born in village	-0.0019	-0.0967	0.0428
Spouse born in village	0.0342*	0.0792	0.0453
Estimated acreage 1990	-0.0007	-0.0060	0.0002
(sqrt) Number of bulls1990	0.0188	0.0296	-0.0224
(sqrt) Number of cows/heifers 1990	0.0057	0.0296	0.0027
Owned radio in 1990	0.0913	0.1040	0.0549
Owned bicycle in 1990	-0.0299	0.0062	-0.0013
Only secondary source of income resource dependent 1990 (c.f. income not resource dep)	0.1184	-0.0599	0.1867*
Only primary source of income resource dependent 1990	0.1246**	-0.0383	0.1390***
Both primary and secondary source of income resource dependent 1990	0.2268***	0.0103	0.2474***
Number of observations	425	445	445
Mean of dependent variable	83.0	29.9	78.8
Mean predicted probability of prog/org	85.8	27.4	80.9
Pseudo R^2	0.1211	0.1847	0.0916

A. Reported coefficients represent the effect of a unit change in explanatory variable on probability of a program or organization being present at the mean of the data. Coefficients are adjusted for sampling weights and stratification, and are robust to heteroskedasticity. Intercept is not reported.

B. Variables dropped – predict success perfectly.

*, **, *** mean coefficient statistically significant at 10 percent, 5 percent and 1 percent levels respectively.

We also consider whether the primary or secondary source of income of the household is dependent upon farming or some other natural resource based enterprise (for example fuelwood intensive enterprises such as brick-making and beer brewing). We expect households with a high degree of resource dependence (i.e. those households where both the primary and secondary source of household income are related to agriculture or natural resources) to be more involved in agriculture or environment focused organizations than households less dependent on natural resources for income.[14, 15]

In general social capital is an important determinant in household involvement in organizations. Households where the head is from a dominant ethnic group (e.g. Banyankore and other southwest highland peoples), or where the head's spouse was born in the village are more likely to be involved in programs and organizations. Human capital is also an important determinant in our regressions. Female headed households and households with higher proportions of females are more likely to be involved in programs and organizations. We also find that higher levels of education of the household head are positively and strongly associated with involvement in agriculture or environment related organizations. Note also that all households with education beyond "O" Level participated in some kind of organization. This is a significant result, even though the variable had to be dropped. We find that resource dependence is positively correlated with household level involvement in programs and organizations. However,

[14] Our regressions include the total number of households in our survey as we found that households reported involvement in a wider range of organizations at the household level than was indicated in the community survey. We ran a second set of regressions including only those households with a program or organization present in their LC1 (in keeping with our conceptual framework as presented in Figure 1) and found similar results.

[15] Regressions were checked for multicollinearity using variance inflation factor (VIF). The maximum VIF of any of our explanatory variables was 8.83, indicating that multicollinearity is not a problem in our models.

surprisingly this is not the case for household involvement in programs focused on agriculture and the environment.

EXPLANATORS OF HOUSEHOLD ADOPTION OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES – DO PROGRAMS AND ORGANIZATIONS MATTER?

Whether the presence of an organization in a community and/or a household's level of involvement in an organization contributes at least in part to the adoption of new technologies has important implications for the future role that organizations will have in providing an enabling environment for sustainable land management in Uganda. In our final set of regressions we use the adoption of selected land management technologies in 2000 as our dependent variables. We focus on five technologies that have been adopted by at least 10 percent of the households in our sample: use of inorganic fertilizer, pesticides, crop residues, mulching, and use of animal manure as fertilizer.

Our explanatory variables include those factors that we hypothesize will directly affect the adoption of land management technologies. We use the agro-ecological potential of the LC1s in which the households are located, as well as market access and population density as described in the community level regressions. We hypothesize that the costs and returns associated with technology adoption will be a function of agroclimatic factors, as well as access to markets, and population density (Pender, Scherr and Duron 2001). We also consider the population growth rate in the community, hypothesizing that high rates of population growth may prompt the adoption of land management technologies to compensate for land use pressure. To provide information about household level access to infrastructure we include average distance from all parcels of land the household owned or operated to the nearest all weather road and

nearest market. We also consider the average distance from the household to each parcel owned or operated by the household. Travel time to plots as well as the distance inputs such as animal manure need to be carried will influence whether households adopt different technologies.

We include several household level variables to describe human, social and physical capital. We include whether the household is female headed, the age of the household head, the education level of the household head, and whether the household head was born in the village as indicators of household level human and social capital. We are uncertain of the effect of gender of household head on technology adoption. Female-headed households are likely to have significant constraints on their time, possibly making them unlikely to undertake labor-intensive technologies such as manure collection. We also include information on the household labor force. We hypothesize that larger households will be more likely to adopt labor-intensive land management technologies. Asset ownership is indicated by the estimated total area of land the household owned or operated in 2000, as well as the number of bulls and cattle the household owned in 2000, and whether the household owned at least one radio or one bicycle. Households with greater wealth may be more likely to undertake land management technologies that offer medium-to long-run returns due to lower discount rates, and less binding cash constraints (Pender 1996; Holden, Shiferaw and Wik 1998; Pender and Kerr 1998). We expect households with low asset levels to undertake technologies such as using animal manure as fertilizer - that offer short-run returns.

Access to both informal and formal credit may be important indictors of whether households can obtain access to external inputs such as inorganic fertilizer, improved

seed, pesticides etc. We hypothesize that access to credit will have a positive effect on the adoption of technologies purchased with cash. Where access to credit is poor, the adoption of technologies that do not require the purchase of external inputs such as use of manure or mulch may be greater. We also consider the effect of contact with an extension worker in 2000. We hypothesize that contact with extension will be positively correlated with adoption of the various land management technologies we consider. With respect to land tenure, we expect that adoption of technologies such as tree planting that yield benefits over the medium to long-term will be associated with more secure forms of land tenure such as freehold (Feder and Onchan 1997). Tenure security also may increase the value of land as collateral for credit, thus potentially increasing the adoption of technologies requiring cash inputs (Ibid). As with the last set of regressions, we consider the level of dependence of the household on natural resource related primary and secondary income sources. We hypothesize that households are more likely to undertake various sustainable land management technologies when their livelihoods are more dependent on natural resources.

Finally, we include the presence of agriculture or environment related programs in the community, and the presence of a program or organization focused on the indirect causes of land degradation in the LC1 as potential determinants of the adoption of various technologies.[16] We hypothesize that the presence of an agriculture or environment related program increases the likelihood of the household adopting various land management technologies. We also include household involvement in organizations by the main focus of the organization in our regressions. Similarly we expect that

[16] To control for endogenous program and organization presence and participation, regressions were run with both actual and predicted probabilities of program or organization presence/involvement. The robustness of the results to use of predicted probabilities is reported in the results.

households involved in agriculture or environment related organizations are more likely to adopt sustainable land management technologies. However, household level involvement in other types of organizations may also affect technology adoption.

Note that we do not include variables related to community level infrastructure and poverty in 1990 from our first set of regressions. We also omit variables pertaining to ethnicity and religion that were used in our second set of regressions. The variables that have been excluded from our two-stage probit model, but that were included in our earlier models are instrumental variables used to help identify the effects of programs and organizations using predicted values to control for endogeneity of program placement and participation. Consider for example ethnicity – we expect that stature in the community is likely to be directly related to household level involvement in programs and organizations. As we have already pointed out, organizations may seek out community leaders to work with, or leaders themselves may organize groups within the community. However, we do not expect social capital to directly cause the adoption of land management technologies, controlling for households participation in programs and organizations. Regression results are presented in Table 7.[17]

Our findings with respect to the presence of agriculture or environment focused programs and organizations in a community provide limited evidence that they are directly affecting household adoption of land management technologies. We found strong positive association between the adoption of pesticides and the presence of an agriculture or environment focused program or organization in a community. However, agriculture and environment programs and organizations functioning in communities were

[17] Regressions using actual and predicted values were checked for multicollinearity using variance inflation factor (VIF). The maximum VIF of any of our explanatory variables was 8.05, indicating that multicollinearity is not a problem in our models.

negatively associated with the use of animal manure. One possible explanation for this is that the knowledge spillover effects of programs and organizations may be greater for purchased inputs yielding high short-term benefits than for labor-intensive on-farm organic alternatives. When we consider the effects of direct household involvement in programs and organizations, we find significant results for two of the five technologies we consider. Household involvement in agriculture/environment organizations is associated with higher likelihood of adopting inorganic fertilizer (a purchased input), and mulching (a labor-intensive organic technology). Thus, more direct involvement in programs and organizations may be required to promote the adoption of land management practices.

We find a negative association between household involvement in infrastructure-focused organizations and the adoption of inorganic fertilizer. Perhaps such households are less focused on crop production and have higher returns to labor in non-farm activities than other households. We found positive associations between household participation in poverty oriented programs and organizations and use of mulching and pesticides. We also found a positive association between household level involvement in credit and community service oriented programs and organizations and the adoption of pesticides. Such organizations enable poorer households to purchase inputs such as pesticides.

Table 7 – Determinants of investment in selected land management practices 2000

	INORGANIC FERTILIZER	PESTICIDES	CROP RESIDUES	MULCHING	ANIMAL MANURE
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Presence of ag/env focused program or organization in LC1	-0.0013^{---}	0.2195***	0.0068^{++}	-0.0199	-0.0834*
Presence of program or organization focused on indirect causes of land degradation in LC1	-0.0081^{+++}	-0.0146^{++}	0.1048***	-0.0070	-0.0153
Household involvement in ag/env focused organization	0.0252**$^{+++}$	0.0237^{++}	-0.0033^{---}	0.1308**	-0.0499
Household involvement in infrastructure focused organization	-0.0105***	0.0073	0.0402	-0.0663	0.0185
Household involvement in credit focused organization	0.0079	0.1014**	0.0207	-0.0218	-0.0303
Household involvement in poverty alleviation focused organization	0.0009^{---}	0.1957***	0.0078^{++}	0.1298*	0.0512
Household involvement in community service focused organization	0.0001^{+++}	0.1090**	0.0168^{-}	0.0683	0.0412^{+++}
Agricultural potential (cf. Unimodal)					
Bimodal low	-0.0098**$^{---}$	-0.1947***$^{-}$	-0.1235**$^{---}$	0.2904**	0.0474
Bimodal medium	-0.0028	0.0217	-0.1151**$^{--}$	-0.1281**$^{---}$	-0.1954***$^{---}$
Bimodal high	-0.0450***$^{---}$	-0.1746**$^{--}$	-0.2845***---	0.0605	-0.1372**$^{-}$
Southwest highlands	-0.0144***$^{---}$	-0.1609	-0.1332***$^{--}$	0.1309	-0.0744
Eastern highlands	0.0430^{---}	0.1528	-0.1128*	-0.0414	0.3214*
Market access (low/high)	-0.0009	-0.0752	-0.2112***$^{---}$	-0.1562***	0.0658
Population density (low/high)	0.0117*$^{+++}$	0.0859**$^{+++}$	0.0774*	0.0599	0.0870*
Altitude (m.a.s.l.)	0.0000**$^{+++}$	0.0001^{+}	0.0001	0.0002	-0.0001
Population growth rate (%)	-0.0004	0.0026	-0.0011	-0.0025	-0.0125**
(sqrt) Average distance from all parcels to all weather road (km)	-0.0037	-0.0279	0.0020	-0.0111	-0.0254
(sqrt) Average distance from all parcels to market (km)	0.0055*	0.0694***$^{++}$	0.0315*$^{+}$	-0.0112	0.0272
(sqrt) Average distance from all parcels to residence (km)	0.0012	-0.0284	0.0190	0.0070	0.0246
Education level of household head (cf. none)					
Some primary or completed primary	0.0033	-0.2559***$^{---}$	0.0324	-0.0182	-0.2891***$^{---}$
More than primary up to O-levels	0.0350	-0.1088^{---}	0.0757^{++}	-0.0146	-0.1292**$^{---}$
Beyond O-levels	0.0412^{--}	-0.0977^{---}	0.3918**$^{++}$	0.0831	-0.0941^{--}
Female household head	0.1357***	-0.0873	-0.0238	-0.0730	0.1063
(ln) Age of household head	-0.0056^{---}	-0.1289^{---}	0.0442^{++}	0.0728	-0.2316***$^{---}$
Household head born in village	0.0019^{+}	0.1053*$^{+++}$	0.0153	-0.0527	-0.0892*
(sqrt) Number of males in household	0.0049^{+++}	0.0096	0.1365***$^{+++}$	-0.0031	0.1346***$^{+++}$
(sqrt) Number of females in household	0.0119**	-0.0142	-0.0755**	-0.0371	0.0249
Estimated acreage 2000	-0.0012**$^{---}$	0.0028	0.0012	0.0006	-0.0052**$^{-}$
(sqrt) Number of bulls 2000	0.0084^{+}	0.0204	-0.0301	0.0903**$^{++}$	-0.016
(sqrt) Number of cows/heifers 2000	-0.0011^{--}	-0.0164	0.0115^{++}	-0.0211	0.0355*$^{+}$
Owned radio in 2000	0.0024	0.0084	-0.0185	0.0620^{+}	0.0656
Owned bicycle in 2000	-0.0042	0.0455	-0.0141	0.0781*	-0.0166
Formal credit available in village in 2000	-0.0020	0.1903*	-0.0864	-0.1148^{-}	-0.2519**$^{--}$

Informal credit available in village in 2000	-0.0051	0.1452	-0.0160	-0.0835^{--}	-0.2903***$^{---}$
Contact with extension in 2000	0.0648***$^{+++}$	0.1463***$^{+++}$	-0.0452	0.1123**$^{+++}$	0.1290**$^{++}$
Tenure status of primary parcel (cf. freehold)					
Leasehold	-0.0083*$^{-}$	-0.1617*	0.0802	0.2565	-0.0538
Mailo	-0.0041	0.0940	0.1934***$^{++}$	0.2196**$^{++}$	0.1027
Customary	-0.0282***$^{---}$	0.0054	0.0486	0.0209	-0.0316
Only secondary source of income resource dependent 1990 (c.f. income not resource dep)	0.0281	-0.0854	0.0278	-0.0595	0.3767**$^{+}$
Only primary source of income resource dependent 1990	0.0016	-0.1013	0.0344	0.0156	0.2183*
Both primary and secondary source of income resource dependent 1990	-0.0089^{-}	-0.1409*	-0.0161	0.0125	0.083
Number of observations	445	445	445	445	445
Mean of dependent variable	10.0	23.8	17.6	20.4	23
Mean predicted probability of adoption	1.0	16.6	12.3	10.8	13.7
Pseudo R^2	0.4610	0.2543	0.2340	0.3266	0.326

A. Reported coefficients represent the effect of a unit change in explanatory variable on probability of a program or organization being present at the mean of the data. Coefficients are adjusted for sampling weights and stratification, and are robust to heteroskedasticity. Intercept is not reported.

*, **, *** mean coefficient statistically significant at 10 percent, 5 percent and 1 percent levels respectively, $^{+,++,+++}$ and $^{-,--,---}$denote level of positive or negative significance when predicted probabilities of programs and organizations are used in regressions

In general, with the exception of organizations focused on agriculture/ environment, credit, and poverty alleviation we do not have strong results linking involvement in programs and organizations to the adoption of land management technologies. However, community survey respondents perceived strong positive impacts of several types of organizations on crop production, land quality and livestock production. Additional research is needed to consider the effect of involvement in programs and organizations on crop productivity, livestock productivity, and other livelihood strategies.

With respect to the other determinants of adoption of various land management technologies we had somewhat mixed results among our five regressions. In general we found that households with higher numbers of male members were more likely to adopt organic technologies such as manuring and crop residues. Female headed households and households with more females were more likely to adopt inorganic fertilizer. Households with more cattle, bulls, and bicycles were more likely to adopt some technologies (manuring and mulching), which supports our hypothesis that wealthier households will be more likely to invest in land management technologies characterized by medium to long-term returns. We also find that households with extension contact are more likely to adopt inorganic fertilizer, manuring, mulching and pesticides. Education of household head, and age of household head have varying effects on technology adoption. Households with older heads were less likely to use inorganic fertilizer, pesticides, and manure. Access to both formal and informal credit was negatively associated with adoption of animal manure in 2000, but positively associated with pesticide adoption. Households where only the primary or secondary source of income was resource

dependent were more likely to use animal manure: whereas households with resource dependent primary and secondary income sources were less likely to use pesticides.

Better market access is associated with less use of some organic practices such as incorporating crop residues and mulching, possibly due to higher labor opportunity costs or higher demand for such organic materials in places of better access. Higher population density is associated with greater likelihood of using fertilizer, manure, crop residues, and pesticides, and smaller land area owned is also associated with more fertilizer and manure use. These findings support the Boserupian hypothesis of population- induced intensification (Boserup 1965).

5. CONCLUSIONS AND POLICY IMPLICATIONS

Government devolution of infrastructure and services is taking place in Uganda. Of particular relevance to the Plan for the Modernization of Agriculture is the role that NGOs and CBOs will play in fulfilling roles traditionally filled by government programs. Our analysis of programs and organizations functioning at the community level indicates that during the 1990s government programs were better distributed throughout Uganda than NGOs and CBOs, and that in general, government programs focused on poorer communities. As devolution takes place it is worth considering how these roles will be fulfilled by NGOs and CBOs. Providing incentives for NGOs and CBOs to locate in less-favored areas may ensure that these communities do not experience negative effects due to devolution. This is particularly important to the delivery of land management technologies to smallholders as the Government of Uganda moves towards demand driven fee-for-service extension. The ability of communities or individual households to

identify extension needs and request services will be influenced by access to information on technologies and options available to smallholders.

With respect to household level involvement in programs and organizations we found relatively high levels of involvement in credit and community service oriented NGOs and CBOs. Fewer households were involved in organizations focused on agriculture and the environment. We found that female-headed households and households with high numbers of females were more likely to be involved in organizations. Strong female involvement in organizations is encouraging news, and this may have implications for the adoption of land management technologies. If women are able to influence household level decision making regarding the adoption of land management technologies, then higher proportions of women involved in organizations may have positive implications for technology adoption. Recall that female headed households, and households with higher numbers of females were more likely to use inorganic fertilizer. However, it may be the case that women prioritize education, health and/or basic needs ahead of land management. Our data indicate that high proportions of women are involved in community service focused organizations that generally do not deal with land management issues. Further investigation into household level decision-making regarding technology adoption is required.

With respect to social capital and household involvement in organizations we found that households where the head belonged to a dominant ethnic group were in some cases more likely to be involved in organizations (for example, Acholi and Langi in the north, and Banyankore and other dominant groups in the southwestern highlands). Also, having the spouse born in the village increased the likelihood of involvement in

organizations focusing on the indirect cause of land degradation. These findings indicate the importance of social capital in organizational involvement, and suggest that households with weak social capital may be excluded from participation. With respect to assets – we found that households with smaller land holdings were more likely to be involved in infrastructure or credit focused programs and organizations and more likely to use inorganic fertilizer and manure, indicating that they are farming more intensively. Households facing land use constraints may be participating in organizations as a way of learning about or becoming involved in both farm and off-farm opportunities.

The results of our econometric analysis of the determinants of adoption of land management technologies indicate that the presence of an agriculture or environment focused program or organization at the community level had a negative effect on the adoption of animal manuring and a positive affect on the adoption of pesticides. This suggests that spillover effects of programs and organizations may be greater for technologies that have short-term benefits, and which require some degree of coordination to be most effective. For example, technologies such as pest management are most effective when a group of households with contiguous cropping fields use them (Knox, Meinzen-Dick and Hazell 2002). Household level involvement in an agriculture or environment focused organization had a positive effect on the adoption of inorganic fertilizer and mulching. Adoption of land management technologies such as manuring that yield longer-term benefits apparently do not spill over to non-participants in local programs and organizations. Thus, direct involvement of households in programs and organizations that promote such technologies may be necessary to ensure technology diffusion throughout communities.

This information may be taken as an indicator of the effectiveness or impact of agriculture and environment focused organizations in Uganda, and should be considered in the broader context of the government devolution of services to NGOs and CBOs. Further analysis of additional technologies is required to determine whether agriculture and environment related programs are positively affecting land management in Uganda. One possible explanation for our weak results regarding the effect of these programs and organizations on the adoption of land management technologies is that smallholders may be receiving training on land management, but not actually adopting the technologies. If this is the case, there is a need to evaluate the role and effectiveness of these organizations. There is evidence of limited profitability of many land management technologies in Uganda. Analysis of the productivity impacts of land management technologies including the use of inorganic fertilizer, manuring, improved fallows and others, indicates limited benefits to adopting these technologies in the short-run (Nkonya et al. 2002). This emphasizes the importance of identifying profitable technologies, or applying technologies to more profitable crops.

REFERENCES

Belshaw, D., P. Lawrence and M. Hubbard. 1999. Agricultural tradables and economic recovery in Uganda: The limitations of structural adjustment in practice*, World Development,* 27(4):673-690.

Boserup, E. 1965. *The Conditions of Agricultural Growth.* New York: Aldine Publishing Company.

Brett, E.A. 1994. Rebuilding organization capacity in Uganda under the National Resistance Movement, *The Journal of Modern African Studies,* 32(1):53-80.

Brett, E.A. 1991. Rebuilding survival structures for the poor: organizations options for development in the 1990s. In *Changing Uganda,* Holger Bernt Hansen and Michael Twaddle eds.. Athens, OH: Ohio State University.

DENIVA. 2001. *Notes on the NGO Amendments Bill for the Meeting Between DENIVA.* http://www.deniva.or.ug/deniva_meet.htm

Dicklitch, Susan. 1998. *The elusive promise of NGOs in Africa: Lessons from Uganda.* New York: St. Martin's Press Inc.

Farrington, J. and A. Bebbington. 1993. Reluctant partners? Non-government organizations, the state and sustainable agricultural development. London and New York: Routledge.

Feder, Gershon and Tongroj Onchan. 1987. Land ownership security and investment in Thailand. *American Journal of Agricultural Economics* 69(2):311-320.

Holden, S.T., B. Shiferaw, and M. Wik. 1998. Poverty, market imperfections and time preferences: Of relevance for environmental policy? *Environment and Development Economics* 3: 105–130.

Howes, Mick. 1997. NGOs and the development of local institutions: A Ugandan case-study, *The Journal of Modern African Studies,* 35(1): 17-35.

Hyden, G. 1983. *No shortcuts to progress: African development management in perspective.* Berkeley and Los Angeles: University of California Press.

International Monetary Fund (IMF). 1996. Uganda: ESAF. *IMF Survey,* 24(23).

International Service for National Agricultural Research (ISNAR). 1988. *Republic of Uganda establishment of a national agricultural research organization (NARO).* The Hague, the Netherlands: International Service for National Agricultural Research.

Knox, A. R. Meinzen-Dick and P. Hazell. Property rights, collective action and technologies for natural resource management: A conceptual framework. In *Innovation in Natural Resource Management: The Role of Property Rights and Collective Action in Developing Countries,* R. Meinzen-Dick, A. Knox, F. Place and B. Swallow eds. Baltimore, MD: Johns Hopkins University Press.

Mamdami, S. 1993. *Pluralism and the right of association.* Working Paper No. 29. Kampala: Centre for Basic Research.

Ministry of Agriculture, Animal Husbandry and Fisheries, Republic of Uganda (MAAIF). 1999. *Plan for the modernization of agriculture – Land management (soil fertility) issues and options paper.* Draft. Soil Fertility Initiative Working Group, Kampala, Uganda.

Mukherjee, C., H. White and M. Wuyts. 1998. *Econometrics and data analysis for developing countries.* London: Routledge.

Nabuguzi, E. 1995. Popular initiatives in service provision in Uganda. In *Service provision under stress in East Africa: The state, NGOs and people's organizations in Kenya, Tanzania and Uganda*, J. Semboya and O. Therkildesen eds. Portsmouth: Heinemann.

Nkonya, E., J. Pender, D. Ssserunkuuma and P. Jagger. 2002. *Development pathways and land management in Uganda.* Paper presented at Workshop on Policies for Improved Land Management in Uganda, Africana Hotel, Kampala, Uganda, April 17-18 2002.

Pender, J. 1996. Discount rates and credit markets: Theory and evidence from rural India. *Journal of Development Economics* 50: 257–296.

Pender, J. and Kerr, J. 1998. Determinants of farmers' indigenous soil and water conservation investments in India's semi-arid tropics. *Agricultural Economics* 19, 113-125.

Pender, J.P., S. Scherr, and G. Duron. 2001. Pathways of development in the hillside areas of Honduras: Causes and implications for agricultural production, poverty and sustainable resource use. In *Trade-offs or Synergies: Agricultural Intensification, Economic Development and the Environment,* D.R. Lee and C.B. Barrett eds. Wallingford, UK: CABI Publishing.

Pender, J., P. Jagger, E. Nkonya and D. Sserunkuuma. 2001. *Development pathways and land management in Uganda: Causes and Implications.* Environment and Production Technology Division Discussion Paper No. 85. Washington, DC: International Food Policy Research Institute.

Pender, J. and S. Scherr. 2002. *Organizational development and natural resource management: Evidence from central Honduras.* In *Innovation in Natural*

Resource Management: The Role of Property Rights and Collective Action in Developing Countries, R. Meinzen-Dick, A. Knox, F. Place and B. Swallow eds. Baltimore, MD: Johns Hopkins University Press.

Putnam, Robert. D. 1995. Bowling along: America's declining social capital. *Journal of Democracy* 6 (1).

Sserunkuuma, D., J. Pender and E. Nkonya. 2001. *Land management in Uganda: Characterization of problems and hypotheses about causes and strategies for improvement.* International Food Policy

Research Institute, Environment and Production Technology Division, Washington, D.C. Mimeo.

Stoorvogel, J.J., and E.M.A. Smaling. 1990. *Assessment of soil nutrient depletion in Sub-Saharan Africa: 1983-2000.* Report 28. Wageningen, the Netherlands: Winand Staring Center for Integrated Land, Soil and Water Research.

Uphoff, Norman. 1993. Grassroots organizations and NGOs in rural development: Opportunities for diminishing states and expanding markets. *World Development,* 21 (4): 606-622.

Wood. S. K. Sebastian, F. Nachtergaele, D. Nielsen and A. Dai. 1999. *Spatial aspects of the design and targeting of agricultural development strategies.* Environment and Production Technology Division Discussion Paper No. 44. Washington, D.C.: International Food Policy Research Institute.

LIST OF EPTD DISCUSSION PAPERS

01 *Sustainable Agricultural Development Strategies in Fragile Lands*, by Sara J. Scherr and Peter B.R. Hazell, June 1994.

02 *Confronting the Environmental Consequences of the Green Revolution in Asia,* by Prabhu L. Pingali and Mark W. Rosegrant, August 1994.

03 *Infrastructure and Technology Constraints to Agricultural Development in the Humid and Subhumid Tropics of Africa*, by Dunstan S.C. Spencer, August 1994.

04 *Water Markets in Pakistan: Participation and Productivity*, by Ruth Meinzen-Dick and Martha Sullins, September 1994.

05 *The Impact of Technical Change in Agriculture on Human Fertility: District-level Evidence From India*, by Stephen A. Vosti, Julie Witcover, and Michael Lipton, October 1994.

06 *Reforming Water Allocation Policy Through Markets in Tradable Water Rights: Lessons from Chile, Mexico, and California*, by Mark W. Rosegrant and Renato Gazri S, October 1994.

07 *Total Factor Productivity and Sources of Long-Term Growth in Indian Agriculture*, by Mark W. Rosegrant and Robert E. Evenson, April 1995.

08 *Farm-Nonfarm Growth Linkages in Zambia*, by Peter B.R. Hazell and Behjat Hoijati, April 1995.

09 *Livestock and Deforestation in Central America in the 1980s and 1990s: A Policy Perspective*, by David Kaimowitz (Interamerican Institute for Cooperation on Agriculture. June 1995.

10 *Effects of the Structural Adjustment Program on Agricultural Production and Resource Use in Egypt,* by Peter B.R. Hazell, Nicostrato Perez, Gamal Siam, and Ibrahim Soliman, August 1995.

11 *Local Organizations for Natural Resource Management: Lessons from Theoretical and Empirical Literature*, by Lise Nordvig Rasmussen and Ruth Meinzen-Dick, August 1995.

12 *Quality-Equivalent and Cost-Adjusted Measurement of International Competitiveness in Japanese Rice Markets*, by Shoichi Ito, Mark W. Rosegrant, and Mercedita C. Agcaoili-Sombilla, August 1995.

13 *Role of Inputs, Institutions, and Technical Innovations in Stimulating Growth in Chinese Agriculture*, by Shenggen Fan and Philip G. Pardey, September 1995.

14 *Investments in African Agricultural Research*, by Philip G. Pardey, Johannes Roseboom, and Nienke Beintema, October 1995.

15 *Role of Terms of Trade in Indian Agricultural Growth: A National and State Level Analysis*, by Peter B.R. Hazell, V.N. Misra, and Behjat Hoijati, December 1995.

16 *Policies and Markets for Non-Timber Tree Products*, by Peter A. Dewees and Sara J. Scherr, March 1996.

17 *Determinants of Farmers' Indigenous Soil and Water Conservation Investments in India's Semi-Arid Tropics*, by John Pender and John Kerr, August 1996.

18 *Summary of a Productive Partnership: The Benefits from U.S. Participation in the CGIAR*, by Philip G. Pardey, Julian M. Alston, Jason E. Christian, and Shenggen Fan, October 1996.

19 *Crop Genetic Resource Policy: Towards a Research Agenda*, by Brian D. Wright, October 1996.

20 Sustainable Development of Rainfed Agriculture in India, by John M. Kerr, November 1996.

21 *Impact of Market and Population Pressure on Production, Incomes and Natural Resources in the Dryland Savannas of West Africa: Bioeconomic Modeling at the Village Level,* by Bruno Barbier, November 1996.

22 *Why Do Projections on China's Future Food Supply and Demand Differ?* by Shenggen Fan and Mercedita Agcaoili-Sombilla, March 1997.

23 *Agroecological Aspects of Evaluating Agricultural R&D,* by Stanley Wood and Philip G. Pardey, March 1997.

24 *Population Pressure, Land Tenure, and Tree Resource Management in Uganda*, by Frank Place and Keijiro Otsuka, March 1997.

25 *Should India Invest More in Less-favored Areas?* by Shenggen Fan and Peter Hazell, April 1997.

26 *Population Pressure and the Microeconomy of Land Management in Hills and Mountains of Developing Countries*, by Scott R. Templeton and Sara J. Scherr, April 1997.

27 *Population Land Tenure and Natural Resource Management: The Case of Customary Land Area in Malawi*, by Frank Place and Keijiro Otsuka, April 1997.

28 *Water Resources Development in Africa: A Review and Synthesis of Issues, Potentials, and Strategies for the Future*, by Mark W. Rosegrant and Nicostrato D. Perez, September 1997.

29 *Financing Agricultural R&D in Rich Countries: What's Happening and Why?* by Julian M. Alston, Philip G. Pardey, and Vincent H. Smith, September 1997.

30 *How Fast Have China's Agricultural Production and Productivity Really Been Growing*? by Shenggen Fan, September 1997.

31 *Does Land Tenure Insecurity Discourage Tree Planting? Evolution of Customary Land Tenure and Agroforestry Management in Sumatra*, by Keijiro Otsuka, S. Suyanto, and Thomas P. Tomich, December 1997.

32 *Natural Resource Management in the Hillsides of Honduras: Bioeconomic Modeling at the Micro-Watershed Level*, by Bruno Barbier and Gilles Bergeron, January 1998.

33 *Government Spending, Growth, and Poverty: An Analysis of Interlinkages in Rural India*, by Shenggen Fan, Peter Hazell, and Sukhadeo Thorat, March 1998. Revised December 1998.

34 *Coalitions and the Organization of Multiple-Stakeholder Action: A Case Study of Agricultural Research and Extension in Rajasthan, India*, by Ruth Alsop, April 1998.

35 *Dynamics in the Creation and Depreciation of Knowledge and the Returns to Research*, by Julian Alston, Barbara Craig, and Philip Pardey, July, 1998.

36 *Educating Agricultural Researchers: A Review of the Role of African Universities*, by Nienke M. Beintema, Philip G. Pardey, and Johannes Roseboom, August 1998.

37 *The Changing Organizational Basis of African Agricultural Research*, by Johannes Roseboom, Philip G. Pardey, and Nienke M. Beintema, November 1998.

38 *Research Returns Redux: A Meta-Analysis of the Returns to Agricultural R&D*, by Julian M. Alston, Michele C. Marra, Philip G. Pardey, and T.J. Wyatt, November 1998.

39 *Technological Change, Technical and Allocative Efficiency in Chinese Agriculture: The Case of Rice Production in Jiangsu*, by Shenggen Fan, January 1999.

40 *The Substance of Interaction: Design and Policy Implications of NGO-Government Projects in India*, by Ruth Alsop with Ved Arya, January 1999.

41 *Strategies for Sustainable Agricultural Development in the East African Highlands*, by John Pender, Frank Place, and Simeon Ehui, April 1999.

42 *Cost Aspects of African Agricultural Research*, by Philip G. Pardey, Johannes Roseboom, Nienke M. Beintema, and Connie Chan-Kang, April 1999.

43 *Are Returns to Public Investment Lower in Less-favored Rural Areas? An Empirical Analysis of India*, by Shenggen Fan and Peter Hazell, May 1999.

44 *Spatial Aspects of the Design and Targeting of Agricultural Development Strategies*, by Stanley Wood, Kate Sebastian, Freddy Nachtergaele, Daniel Nielsen, and Aiguo Dai, May 1999.

45 *Pathways of Development in the Hillsides of Honduras: Causes and Implications for Agricultural Production, Poverty, and Sustainable Resource Use*, by John Pender, Sara J. Scherr, and Guadalupe Durón, May 1999.

46 *Determinants of Land Use Change: Evidence from a Community Study in Honduras*, by Gilles Bergeron and John Pender, July 1999.

47 *Impact on Food Security and Rural Development of Reallocating Water from Agriculture*, by Mark W. Rosegrant and Claudia Ringler, August 1999.

48 *Rural Population Growth, Agricultural Change and Natural Resource Management in Developing Countries: A Review of Hypotheses and Some Evidence from Honduras,* by John Pender, August 1999.

49 *Organizational Development and Natural Resource Management: Evidence from Central Honduras*, by John Pender and Sara J. Scherr, November 1999.

50 *Estimating Crop-Specific Production Technologies in Chinese Agriculture: A Generalized Maximum Entropy Approach*, by Xiaobo Zhang and Shenggen Fan, September 1999.

51 *Dynamic Implications of Patenting for Crop Genetic Resources*, by Bonwoo Koo and Brian D. Wright, October 1999.

52 *Costing the Ex Situ Conservation of Genetic Resources: Maize and Wheat at CIMMYT*, by Philip G. Pardey, Bonwoo Koo, Brian D. Wright, M. Eric van Dusen, Bent Skovmand, and Suketoshi Taba, October 1999.

53 Past and Future Sources of Growth for China, by Shenggen Fan, Xiaobo Zhang, and Sherman Robinson, October 1999.

54 *The Timing of Evaluation of Genebank Accessions and the Effects of Biotechnology*, by Bonwoo Koo and Brian D. Wright, October 1999.

55 *New Approaches to Crop Yield Insurance in Developing Countries*, by Jerry Skees, Peter Hazell, and Mario Miranda, November 1999.

56 *Impact of Agricultural Research on Poverty Alleviation: Conceptual Framework with Illustrations from the Literature*, by John Kerr and Shashi Kolavalli, December 1999.

57 *Could Futures Markets Help Growers Better Manage Coffee Price Risks in Costa Rica*? by Peter Hazell, January 2000.

58 *Industrialization, Urbanization, and Land Use in China*, by Xiaobo Zhang, Tim Mount, and Richard Boisvert, January 2000.

59 *Water Rights and Multiple Water Uses: Framework and Application to Kirindi Oya Irrigation System, Sri Lanka*, by Ruth Meinzen-Dick and Margaretha Bakker, March 2000.

60 *Community natural Resource Management: The Case of Woodlots in Northern Ethiopia*, by Berhanu Gebremedhin, John Pender and Girmay Tesfaye, April 2000.

61 *What Affects Organization and Collective Action for Managing Resources? Evidence from Canal Irrigation Systems in India*, by Ruth Meinzen-Dick, K.V. Raju, and Ashok Gulati, June 2000.

62 *The Effects of the U.S. Plant Variety Protection Act on Wheat Genetic Improvement*, by Julian M. Alston and Raymond J. Venner, May 2000.

63 *Integrated Economic-Hydrologic Water Modeling at the Basin Scale: The Maipo River Basin*, by M. W. Rosegrant, C. Ringler, DC McKinney, X. Cai, A. Keller, and G. Donoso, May 2000.

64 *Irrigation and Water Resources in Latin America and he Caribbean: Challenges and Strategies*, by Claudia Ringler, Mark W. Rosegrant, and Michael S. Paisner, June 2000.

65 *The Role of Trees for Sustainable Management of Less-favored Lands: The Case of Eucalyptus in Ethiopia,* by Pamela Jagger & John Pender, June 2000.

66 *Growth and Poverty in Rural China: The Role of Public Investments*, by Shenggen Fan, Linxiu Zhang, and Xiaobo Zhang, June 2000.

67 *Small-Scale Farms in the Western Brazilian Amazon: Can They Benefit from Carbon Trade?* by Chantal Carpentier, Steve Vosti, and Julie Witcover, September 2000.

68 *An Evaluation of Dryland Watershed Development Projects in India*, by John Kerr, Ganesh Pangare, Vasudha Lokur Pangare, and P.J. George, October 2000.

69 *Consumption Effects of Genetic Modification: What If Consumers Are Right*? by Konstantinos Giannakas and Murray Fulton, November 2000.

70 *South-North Trade, Intellectual Property Jurisdictions, and Freedom to Operate in Agricultural Research on Staple Crops*, by Eran Binenbaum, Carol Nottenburg, Philip G. Pardey, Brian D. Wright, and Patricia Zambrano, December 2000.

71 *Public Investment and Regional Inequality in Rural China,* by Xiaobo Zhang and Shenggen Fan, December 2000.

72 *Does Efficient Water Management Matter? Physical and Economic Efficiency of Water Use in the River Basin*, by Ximing Cai, Claudia Ringler, and Mark W. Rosegrant, March 2001.

73 *Monitoring Systems for Managing Natural Resources: Economics, Indicators and Environmental Externalities in a Costa Rican Watershed*, by Peter Hazell, Ujjayant Chakravorty, John Dixon, and Rafael Celis, March 2001.

74 *Does Quanxi Matter to NonFarm Employment*? by Xiaobo Zhang and Guo Li, June 2001.

75 *The Effect of Environmental Variability on Livestock and Land-Use Management: The Borana Plateau, Southern Ethiopia*, by Nancy McCarthy, Abdul Kamara, and Michael Kirk, June 2001.

76 *Market Imperfections and Land Productivity in the Ethiopian Highlands*, by Stein Holden, Bekele Shiferaw, and John Pender, August 2001.

77 *Strategies for Sustainable Agricultural Development in the Ethiopian Highlands*, by John Pender, Berhanu Gebremedhin, Samuel Benin, and Simeon Ehui, August 2001.

78 *Managing Droughts in the Low-Rainfall Areas of the Middle East and North Africa: Policy Issues*, by Peter Hazell, Peter Oram, Nabil Chaherli, September 2001.

79 *Accessing Other People's Technology: Do Non-Profit Agencies Need It? How To Obtain It,* by Carol Nottenburg, Philip G. Pardey, and Brian D. Wright, September 2001.

80 *The Economics of Intellectual Property Rights Under Imperfect Enforcement: Developing Countries, Biotechnology, and the TRIPS Agreement*, by Konstantinos Giannakas, September 2001.

81 *Land Lease Markets and Agricultural Efficiency: Theory and Evidence from Ethiopia*, by John Pender and Marcel Fafchamps, October 2001.

82 *The Demand for Crop Genetic Resources: International Use of the U.S. National Plant Germplasm System*, by M. Smale, K. Day-Rubenstein, A. Zohrabian, and T. Hodgkin, October 2001.

83 *How Agricultural Research Affects Urban Poverty in Developing Countries: The Case of China*, by Shenggen Fan, Cheng Fang, and Xiaobo Zhang, October 2001.

84 *How Productive is Infrastructure? New Approach and Evidence From Rural India*, by Xiaobo Zhang and Shenggen Fan, October 2001.

85 *Development Pathways and Land Management in Uganda: Causes and Implications*, by John Pender, Pamela Jagger, Ephraim Nkonya, and Dick Sserunkuuma, December 2001.

86 *Sustainability Analysis for Irrigation Water Management: Concepts, Methodology, and Application to the Aral Sea Region*, by Ximing Cai, Daene C. McKinney, and Mark W. Rosegrant, December 2001.

87 *The Payoffs to Agricultural Biotechnology: An Assessment of the Evidence*, by Michele C. Marra, Philip G. Pardey, and Julian M. Alston, January 2002.

88 *Economics of Patenting a Research Tool*, by Bonwoo Koo and Brian D. Wright, January 2002.

89 *Assessing the Impact of Agricultural Research On Poverty Using the Sustainable Livelihoods Framework*, by Michelle Adato and Ruth Meinzen-Dick, March 2002.

90 *The Role of Rainfed Agriculture in the Future of Global Food Production*, by Mark Rosegrant, Ximing Cai, Sarah Cline, and Naoko Nakagawa, March 2002.

91 *Why TVEs Have Contributed to Interregional Imbalances in China*, by Junichi Ito, March 2002.

92 *Strategies for Stimulating Poverty Alleviating Growth in the Rural Nonfarm Economy in Developing Countries*, by Steven Haggblade, Peter Hazell, and Thomas Reardon, July 2002.

93 *Local Governance and Public Goods Provisions in Rural China*, by Xiaobo Zhang, Shenggen Fan, Linxiu Zhang, and Jikun Huang, July 2002.

94 *Agricultural Research and Urban Poverty in India,* by Shenggen Fan, September 2002.

95 *Assessing and Attributing the Benefits from Varietal Improvement Research: Evidence from Embrapa, Brazil*, by Philip G. Pardey, Julian M. Alston, Connie Chan-Kang, Eduardo C. Magalhães, and Stephen A. Vosti, August 2002.

96 *India's Plant Variety and Farmers' Rights Legislation: Potential Impact on Stakeholders Access to Genetic Resources*, by Anitha Ramanna, January 2003.

97 *Maize in Eastern and Southern Africa: Seeds of Success in Retrospect*, by Melinda Smale and Thom Jayne, January 2003.

98 *Alternative Growth Scenarios for Ugandan Coffee to 2020*, by Liangzhi You and Simon Bolwig, February 2003.

99 *Public Spending in Developing Countries: Trends, Determination, and Impact,* by Shenggen Fan and Neetha Rao, March 2003.

100 *The Economics of Generating and Maintaining Plant Variety Rights in China*, by Bonwoo Koo, Philip G. Pardey, Keming Qian, and Yi Zhang, February 2003.