WORLD BANK TECHNICAL PAPER NO. 370

Work in progress
for public discussion

WTP370
July 1997

Land Degradation in Tanzania

Perception from the Village

Alemneh Dejene
Elieho K. Shishira
Pius Z. Yanda
Fred H. Johnsen

RECENT WORLD BANK TECHNICAL PAPERS

No. 286 Tavoulareas and Charpentier, *Clean Coal Technologies for Developing Countries*

No. 287 Gillham, Bell, Arin, Matthews, Rumeur, and Hearn, *Cotton Production Prospects for the Next Decade*

No. 288 Biggs, Shaw, and Srivastiva, *Technological Capabilities and Learning in African Enterprises*

No. 289 Dinar, Seidl, Olem, Jorden, Duda, and Johnson, *Restoring and Protecting the World's Lakes and Reservoirs*

No. 290 Weijenberg, Dagg, Kampen Kalunda, Mailu, Ketema, Navarro, and Abdi Noor, *Strengthening National Agricultual Research Systems in Eastern and Central Africa: A Framework for Action*

No. 291 Valdés and Schaeffer in collaboration with Errazuriz and Francisco, *Surveillance of Agricultural Price and Trade Policies: A Handbook for Chile*

No. 292 Gorriz, Subramanian, and Simas, *Irrigation Management Transfer in Mexico: Process and Progress*

No. 293 Preker and Feachem, *Market Mechanisms and the Health Sector in Central and Eastern Europe*

No. 294 Valdés and Schaeffer in collaboration with Sturzenegger and Bebczuk, *Surveillance of Agricultural Price and Trade Policies: A Handbook for Argentina*

No. 295 Pohl, Jedrzejczak, and Anderson, *Creating Capital Markets in Central and Eastern Europe*

No. 296 Stassen, *Small-Scale Biomass Gasifiers for Heat and Power: A Global Review*

No. 297 Bulatao, *Key Indicators for Family Planning Projects*

No. 298 Odaga and Heneveld, *Girls and Schools in Sub-Saharan Africa: From Analysis to Action*

No. 299 Tamale, Jones, and Pswarayi-Riddihough, *Technologies Related to Participatory Forestry in Tropical and Subtropical Countries*

No. 300 Oram and de Haan, *Technologies for Rainfed Agriculture in Mediterranean Climates: A Review of World Bank Experiences*

No. 301 Mohan, editor, *Bibliography of Publications: Technical Department, Africa Region, July 1987 to April 1995*

No. 302 Baldry, Calamari, and Yaméogo, *Environmental Impact Assessment of Settlement and Development in the Upper Léraba Basin*

No. 303 Heneveld and Craig, *Schools Count: World Bank Project Designs and the Quality of Primary Education in Sub-Saharan Africa*

No. 304 Foley, *Photovoltaic Applications in Rural Areas of the Developing World*

No. 305 Johnson, *Education and Training of Accountants in Sub-Saharan Anglophone Africa*

No. 306 Muir and Saba, *Improving State Enterprise Performance: The Role of Internal and External Incentives*

No. 307 Narayan, *Toward Participatory Research*

No. 308 Adamson and others, *Energy Use, Air Pollution, and Environmental Policy in Krakow: Can Economic Incentives Really Help?*

No. 309 The World Bank/FOA/UNIDO/Industry Fertilizer Working Group, *World and Regional Supply and Demand Balances for Nitrogen, Phosphate, and Potash, 1993/94-1999/2000*

No. 310 Elder and Cooley, editors, *Sustainable Settlement and Development of the Onchocerciasis Control Programme Area: Proceedings of a Ministerial Meeting*

No. 311 Webster, Riopelle and Chidzero, *World Bank Lending for Small Enterprises 1989-1993*

No. 312 Benoit, *Project Finance at the World Bank: An Overview of Policies and Instruments*

No. 313 Kapur, *Airport Infrastructure: The Emerging Role of the Private Sector*

No. 314 Valdés and Schaeffer in collaboration with Ramos, *Surveillance of Agricultural Price and Trade Policies: A Handbook for Ecuador*

No. 316 Schware and Kimberley, *Information Technology and National Trade Facilitation: Making the Most of Global Trade*

No. 317 Schware and Kimberley, *Information Technology and National Trade Facilitation: Guide to Best Practice*

No. 318 Taylor, Boukambou, Dahniya, Ouayogode, Ayling, Abdi Noor, and Toure, *Strengthening National Agricultural Research Systems in the Humid and Sub-humid Zones of West and Central Africa: A Framework for Action*

No. 320 Srivastava, Lambert, and Vietmeyer, *Medicinal Plants: An Expanding Role in Development*

No. 321 Srivastava, Smith, and Forno, *Biodiversity and Agriculture: Implications for Conservation and Development*

(List continues on the inside back cover)

WORLD BANK TECHNICAL PAPER NO. 370

Land Degradation in Tanzania

Perception from the Village

Alemneh Dejene
Elieho K. Shishira
Pius Z. Yanda
Fred H. Johnsen

The World Bank
Washington, D.C.

Manufactured in the United States of America
First printing July 1997

ISBN 0-8213-3993-1
ISSN: 0253-7494

Alemneh Dejene is a consultant and Coordinator of the Soil Fertility Initiative in the World Bank's Africa Region. Elieho K. Shishira is Director of the Institute of Resources Assessment, University of Dar-es-Salaam. Pius Z. Yanda is a Senior Research Fellow at the Institute of Resource Assessment, University of Dar-es-Salaam. Fred H. Johnsen is Associate Professor at Noragric, the Agricultural University of Norway.

Cover photo by Alemneh Dejene "Cattle grazing in Ethiopia."

Library of Congress Cataloging-in-Publication Data

Land degradation in Tanzania : perception from the village / Alemneh Dejene ... [et al.].
p. cm. — (World Bank technical paper : no. 370)
Includes bibliographical references.
ISBN 0-8213-3993-1
1. Soil degradation—Tanzania—Kondoa District. 2. Agriculture—Environmental aspects—Tanzania—Kondoa District. 3. Land degradation—Control—Government policy—Tanzania—Kondoa District. 4. Farmers—Tanzania—Kondoa District—Attitudes. 5. Land use, Rural—Tanzania—Kondoa District. 6. Farms, Small—Tanzania—Kondoa District. I. Alemneh Dejene. II. Series.
S625.T3L35 1997 97-18344
333.76'137'09678—dc21 CIP

CONTENTS

TABLES

FOREWORD

Inadequate farming practices, deforestation and overgrazing are the primary reasons for declining agricultural productivity in Sub-Saharan Africa. These factors, driven by socio-economic forces, manifest themselves in market, policy and institutional failures.

This study examined the dynamics of the loss of soil fertility and low productivity at the village level. In addition, it looks at the perception and response gap between officials and local land users in the diagnosis and remedy of land degradation. This gap often results in conflict, and is a major constraint to the successful implementation of policies and projects to address land degradation.

The study's findings underscore that sustainable use of land resources and successful policies and programs require appropriate enabling policies and institutional arrangements to encourage intensification of smallholder farming systems. This would, for example, include, increasing the proper use of inorganic and organic amendments, the development of low-cost soil cover and moisture management techniques, and expanding draft power. Policies would also require incorporating proven indigenous practices and knowledge into technical approaches, and ensuring local participation in decision-making.

This study was undertaken by the Environment Group, Africa Region, as a component of the Africa Region's Soil Fertility Initiative. Its findings will help shape investment programs to enhance land productivity in Sub-Saharan Africa.

Kevin Cleaver
Technical Director
Africa Region

ACKNOWLEDGMENTS

A large part of the credit for the successful completion of this study must go to the support of Narendra Sharma at the World Bank who provided overall guidance and supervision and made valuable inputs at all stages. We are also thankful to Cynthia Cook, Isabel Valencia, Simon Rietbergen, and Chirstian Pieri at the World Bank. Walter Lusigi, at the Global Environment Facility (GEF), helped considerably in initiating the study.

At Noragric, Norway, we have benefited from the inputs of Jens Aune and Athanasio Minjas. We are indebted for the valuable contributions and support of Professor Idris Kikula, Director of the Institute of Resource Assessment (IRA), University of Dar-es-Salaam. We are also thankful for the inputs of government agencies such as Land Use Commission, Planning Commission , National Environment Management Council, Ministry of Agriculture, Ministry of Tourism, Natural Resources and Environment, National Soil Service, Regional and District Natural Resource and Livestock Development Office, Regional Commission Office in Dodoma, Soil Conservation Project in Dodoma Region (HADO), and to the World Bank Resident Mission in Tanzania.

The manuscript was carefully reviewed by Professor Hans Hurni at University of Bern, Switzerland, Dr. Sara Scherr, Research Fellow at International Food Policy Research Institute, and Dr. Carlos Baanate, Director of Research and Development at the International Fertilizer Development Center. We are grateful for their valuable comments. The comments of Robert Brinkman and Jeff Tschirley at the Food and Agriculture Organization of the United Nations were helpful. We are also thankful for the editorial assistance of Lawrence Mastri and P.C. Mohan at the World Bank.

It is difficult to acknowledge individually all those who have assisted us during fieldwork. But HADO staff and the Ministry of Agricultural field extension officer were instrumental in the successful completion of the field research. We are grateful to all of them.

Alemneh Dejene

ABSTRACT

Local land users often have different perceptions and responses than officials to the land degradation problem. This has resulted in conflict with officials in diagnosing and solving the problem and is a major constraint to the successful implementation of policies and projects to address land degradation.

The study's findings underscore that sustainable use of land resources and successful policies and programs require appropriate enabling policies and institutional arrangements to encourage intensification of smallholder farming systems. Policies would also require incorporating proven indigenous practices and knowledge into technical approaches, and ensuring local participation in decision-making.

EXECUTIVE SUMMARY

Official and local land users often have quite different perceptions and responses to land degradation problems. This situation impedes successful implementation of policies and projects to address land degradation. Land degradation is also influenced by local ecological and socio-economic forces, and understanding the dynamics of these interactions at the local level would contribute to remedy the problem. Hence, this study examines the most significant issues affecting levels of productivity and land quality at the community and village level, where local land users take decision on cropping and livestock management.

The specific objectives of the study were to examine farmers' perceptions, particularly their understanding and interpretation of factors and indicators which they link to soil erosion and fertility decline, the level of degradation of crop and pastureland, and the institutional capacity to implement soil conservation and fertility measures -- with particular regard to land tenure policies, local organizations and extension service. The investigators also sought to identify the technologies, best practices and indigenous knowledge used by households to control erosion, enhance soil fertility, and increase crop and livestock productivity among smallholders.

Restoration of Soil Fertility

Farmers are aware that soil degradation, in various forms, is taking place on their farms as well as in the surrounding areas. This is based on their perception and interpretation of indicators that reveal certain conditions regarding crop and pastureland. The major indicators farmers cited included rill and gully erosion, water absorption capacity (level of run-off), exposure of roots, crop yield, change in color of crop leaves, stunted crops, emergence of weeds and unpalatable species, appearance of termite mounds, and the disappearance of grass. Most physical and plant species indicators are local and site-specific.

One approach to mitigate land degradation involves intensification of farming using sustainable production systems (such as intercropping, composting, farmyard manure, strip cropping, ploughing crop residue, and agroforestry), and increasing productivity on the same unit of land. The proper use of chemical fertilizer is important for the restoration of soil fertility as well as in the intensification of smallholder farms. Macroeconomic factors, particularly pricing policy, have eliminated fertilizer subsidies, and drastically reduced the demand for and use of fertilizer. There is a linkage between high population density and greater incentives to improve soil productivity since investment in soil fertility and measures to maintain productivity becomes more rewarding and profitable as the scarcity value of land increases with respect to labor. Another approach involves extensification of agriculture by clearing new land, often in an unsustainable way. Extensification is also a means of gaining ownership to new land. Poverty can be a disincentive to undertaking improved land management practices and intensification. Poor farmers living in villages are often engaged in cash labor at the time

of field preparation and their land tends to suffer most from soil erosion and fertility decline.

Farming Practices

Several important aspects of farmer behavior were revealed through the examination of farming practices. For example, deforestation was primarily a result of increasing the area under cultivation, not fuelwood gathering. The use of fire as a land-management tool is widespread. It is a means of reducing the incidence of livestock disease and is also used in clearing new land for agricultural expansion. But it has negative effects -- the destruction of vegetation cover, soil organic matter, lowering the diversity of soil fauna, and increasing erosion. The government's efforts to initiate communal tree planting were not widely accepted, and farmers indicated their preference for individual tree planting on their farms.

Overgrazing

Officials view large herd size and overgrazing as major causes of land degradation. Villagers see livestock as a sign of wealth, and would like to maximize their herd size for their own social, cultural, and economic reasons. This perception tends to encourage overgrazing and land degradation. Officials and extension agents have attempted to solve this problem by enforcing destocking policies. This policy has been unpopular among farmers and difficult to implement. Livestock were temporarily moved into another area, thereby merely transferring the problem. Another unintended outcome of the removal of livestock was a substantial increase in the incidence of malnutrition. Officials tried to alleviate this program by introducing the zero grazing method which focused on improved dairy cows for milk production, and a stall-feeding system. However, this alternative has not been well received since it does not take into account the multiple roles and value of livestock in the farming system.

Land Tenure

The majority of farmers feel secure about the land they cultivate. Customary land tenure authority is vested in local leaders. It is not subject to regulation and can be held in perpetuity by farmers, and thus has not been an impediment to investing in land. Indeed, most farmers have invested in, or improved their land in terms of tree planting, buying fertilizer, using farmyard manure, constructing terraces and water ways, etc. The lack of investment has been more influenced by poverty rather than an unwillingness to invest because of any insecurity of tenure. A more pertinent issue seems to be conflict over grazing rights involving predominantly crop producers and pastoralists. This conflict is more acute where large-scale operators are expanding into traditional pastoral and grazing areas. In areas where there is a large tract of common property resources, the current laissez-faire approach is enhancing conflict and the degradative process.

Extension and Local Organizations

Farmers are reluctant to participate in local associations mainly due to their negative experiences with government-initiated, top-down conservation efforts (such as destocking and labor-intensive conservation measures) and the belief that such an association could be used as a rubber stamp to promote unpopular measures. Furthermore, there are few extension agents at the village level and visits from the extension service are infrequent. Farmers are suspicious of extension agents as they often see their objectives as being the conversion of communal lands into government managed protected areas, which they will not be able to use.

The crucial challenges facing extension services are (a) developing a technical package in improved crop and livestock practices tailored and fine-tuned to a specific farming system and agro-ecological conditions; (b) incorporating tested indigenous knowledge and land management practices into the technical packages; (c) increasing nutrient uptake efficiency by developing the best combination of organic and inorganic fertilization methods; (d) involving civic society and the appropriate local organizations before launching conservation measures; and (e) working closely with research institutions in developing and introducing early maturing and drought-resistant crops.

Conclusions

The sustainable use of land resources and the successful implementation of policies and programs to address the land degradation problem would require enabling policies and institutional arrangements to encourage intensification of the smallholder farming systems. This would include such means as increasing the proper use of inorganic and organic soil amendments, provision of permanent watering points, development of low-cost soil cover and water harvesting techniques, expanding draft power, and strengthening local organization and extension services. At the same time, there is also a need for policies that discourage environmentally damaging land use practices, such as uncontrolled extensification in communally-held land and pastoral areas. An improved system will also require taking into account land users' perspectives, local variations in ecology and socio-cultural conditions, incorporating proven indigenous practices and knowledge into technical approaches, and ensuring local participation in decision-making.

CHAPTER 1

BACKGROUND AND RATIONALE FOR THE STUDY

The Context

Fertile land is crucial to provide a livelihood for most people in Sub-Saharan Africa (SSA). Agricultural land is under enormous pressure from soil degradation, deforestation, inappropriate farming and grazing practices, population growth, fuelwood shortage, land tenure conflicts, lack of effective extension service and local organization, and other institutional and policy shortcomings.

Agricultural production in SSA increased at about 1.5 percent per annum between 1965 and 1990, while population growth averaged close to 3 percent over the same period. This agricultural growth rate is well below the estimated 4 percent per year which is essential for many SSA countries to reduce poverty and attain sustainable growth (Cleaver 1994; Badiane and Delegado 1995). The dismal performance of the agricultural sector (which must be the engine for overall economic development) is being increasingly attributed to the land degradation problem facing many African countries. A recent study (Scherr and Yadav 1996) has identified several subregions in Africa (such as the densely populated highlands in east and central Africa) as "hot spots" where land degradation -- in terms of nutrient depletion and erosion -- pose a serious threat to food security and local economic activity.

The terms "land degradation" and "soil degradation" are often used interchangeably. However, land degradation has a broader concept and refers to the degradation of soil, water, climate, and fauna and flora. Soil degradation refers more to water erosion and wind erosion, as well as chemical, physical, and biological (loss of organic matter) degradation (Hurni, 1996). This study addresses various forms of both land and soil degradation, which is crucial to any real effort to ensure productivity, food security and environmental sustainability.

Declining agricultural productivity and the increasing number of countries devastated by drought in SSA over the past two decades have raised serious concerns among African policy makers about whether the land can support the expanding population, and produce enough to combat poverty and food insecurity. Hence, at the 1992 Earth Summit in Rio de Janeiro, African leaders appealed for an International Convention to Combat Desertification. The Desertification Convention, which is now being ratified by the United Nations member countries, focuses on combating land degradation in the dryland areas of Africa. African countries are now faced with the urgent task of addressing land degradation problems in both marginal and high potential areas.

Major Causes

Socio-economic and political factors have forced many countries in SSA to bring new land under cultivation and to reduce fallow periods to meet the food and fiber needs of the rapidly increasing population. This extensive approach is reflected in low cropping intensity and poor yields per hectare (ha) in SSA. Cropping intensity is 55 percent in SSA -- compared with 110 percent in South Asia -- and the average yield of cereals is about 1 ton per ha in SSA while it is 2.3 tons per ha for the rest of the developing countries (World Bank and FAO 1995). Much of the unutilized land in many parts of SSA is of marginal quality in fragile ecosystems, and extensification of agriculture often results in depletion of soil fertility and in land degradation.

In the densely populated areas of SSA, intensification of agriculture is reducing fallow periods and increasing the farming intensity on crop land. A major part of the cultivable land in SSA (72 percent) suffers from low fertility, loss of soil nutrients, poor soil drainage and steep slopes, and is unlikely to support the population (FAO 1993). Soil degradation is widespread in SSA: about 320 million ha of land have been degraded moderately or severely by overgrazing, deforestation, and poor farming practices, while about 5 million ha are degraded beyond rehabilitation (Oldeman, Hakkeling, Sombroek 1990).

The land degradation process is not well understood, and most studies have centered on the physical aspects of this process. The most significant study on extent and nature of land degradation was that of the Global Assessment of Soil Degradation (GLASOD) study by Oldeman, Hakkeling, and Sombroek. GLASOD defines land degradation as a process that lowers the present or future capacity of the soil to produce goods and services. The most significant single contributor to soil degradation in all regions, including SSA, is water erosion. Other damage comes from wind erosion, chemical degradation, and physical degradation -- in order of importance (Oldeman, van Engelen, and Pulles 1990). Degradation occurs over time, and could have either a negative or a positive impact on land productivity. Certain types of soil degradation, such as geological erosion, are part of the natural process. This study focuses on degradation caused by human activities, and, which, therefore, can be prevented.

In sum, the major causes of land degradation in SSA are overgrazing, inadequate farming practices, and deforestation. Dryland areas, which cover 65 percent of the total land area in SSA, are highly susceptible to erosion and various forms of land degradation. In the dryland areas, overgrazing affects 49 percent of the land, poor farming practices 24 percent and deforestation 27 percent (Oldeman, Hakkeling, and Sombroek 1991). These causal factors, driven by socio-economic and political forces, manifest themselves in market, policy and institutional failures, inadequate technologies and practices, population pressure, poverty, cultural values, and individual behavior (Sharma, Denning, and Cleaver 1995).

Nexus of Poverty, Loss of Soil Fertility, and Low Productivity

In many localized areas of SSA, there is a synergy linking declining food production, high population growth, and natural resource degradation. This nexus dynamic creates a negative synergy that depletes soil productivity and results in a vicious cycle of poverty and food insecurity (Cleaver and Schreiber 1994).

Nutrient loss on arable land is significant in areas strongly affected by the nexus dynamic. Estimates show a net loss of 700 kg of nitrogen(N), 100 kg of phosphorus (P), and 450 kg of potassium (K)per ha in 100 million ha of cultivated lands over the past 30 years (Sanchez, Izac, Valencia, and Pieri 1995). Crop residue and manure, which were once a major source of enriching soil fertility, are being used as fodder and fuelwood. This considerable nutrient loss is reflected in the widening gap between the actual and potential yield for all the major food crops in SSA. For example, average farm yield for maize, sorghum, and wheat is 1.6 mt/ha (metric tons per hectare), 0.5 mt/ha, and 1.5 mt/ha, while the potential yield is 5mt/ha, 2.5 mt/ha and 3.5 mt/ha respectively (Sharma, Denning, and Cleaver 1995).

Loss of soil productivity leads to reduced farm income and food insecurity, particularly among the rural poor. Over 60 percent of the world's poorest people live in marginal areas and face a trade-off between short-term needs and the long-term conservation of natural resources (Leonard 1989). In managing land resources, the poor often have a "short time horizon", and will resort to maximizing their immediate gains and overexploitation of natural resources to secure their basic necessities (World Bank 1992; Holmberg 1991). The poor also face financial and socio-economic constraints. These factors seriously impede improved land management practices and innovations, which lowers the productivity and income of the poor and reinforce the "vicious cycle". Hence, narrowing this productivity gap between actual and potential yield is essential to avoid the poverty and natural resource degradation trap.

Soil degradation incurs substantial loss to productivity. The average loss in crop yields due to erosion for SSA is estimated at 6 percent, and in 1989, 3.6 million tons for cereals, 6.5 million tons for roots and tubers, and 0.36 million tons for pulses were lost by erosion (Lal, 1995). If this erosion level continues, yield loss by the year 2020 would be 14.4 percent (Scherr and Yadav 1996). Based on the data generated by Dregne and Chou on the areas of dryland by categories of land use and degradation level (Dregne and Chou 1992), the average productivity loss for irrigated land is 6.8 percent, for rainfed cropland, 14 percent and for rangeland, 45 percent (Crosson and Anderson 1995).

Data Availability

Until recently, there was no reliable data on the rate and extent of land degradation. Part of the problem has been measuring the impact of change on land productivity. GLASOD completed the most significant assessment, which indicated that cropland and pasture degradation are more widespread in Africa than other regions. About 65 percent of the cropland area and 31 percent of the pastureland in SSA are affected by degradation (Oldeman, Hakkeling, and Sombroek, 1991). These figures, however, are only indicative, since the methodologies for such assessment are still under development. There is also very little data available on lands being improved or rehabilitated. A new initiative coordinated by the University of Berne is under way, the World Overview of Conservation Approaches to Technologies (WOCAT), which attempts to assess soil and water conservation experience worldwide using a decentralized approach (Hurni and others 1995).

Land degradation is often inferred from other features (such as soil characteristics, land use, rainfall, slope) which may have an impact on land degradation. This method is plagued by sampling, extrapolation, and calibration errors. Some of the advanced methodologies used to assess land degradation, such as remote sensing, GIS, and aerial photography, emphasize easily observable features and indicators of change (such as gullies, landslide, encroachment of undesirable species), and link these changes to the active process of land degradation. Approaches that compare existing land use practice with "ideal" utilization assumes the ideal to be better. For example, the concept of carrying capacity is derived from such a comparison and has been used by officials to formulate policies and implement projects on rangeland degradation. Yet, the notion of carrying capacity does not explain the variation in local circumstances and has resulted in conflict with local land users (Biot 1991; Abel and Blaikie 1989; Behnke and Scoones 1993; Bartels, Norton, and Perrier 1993).

Many countries in SSA lack a systematic framework in assessing soil and land degradation. Data on land resources are not reported periodically, making assessment difficult. This is partly due to the lack of institutional capacity and is a serious impediment to formulating conservation projects and restoring soil productivity. At the Earth Summit, nations agreed to implement the *Agenda 21* document (blueprint for Sustainable Development) which makes several references to monitoring, reporting, and taking appropriate action regarding land (UNCED 1992). This has sparked a corresponding interest in developing indicators and several studies are underway on environment and land quality indicators (Pieri and others1995, Hammond and others 1995; OECD 1994; Adriaanse 1993).

Need for a Practical Approach

The diagnoses of and the solutions to the land degradation problem vary greatly across disciplines and among stakeholders. The literature shows at least three major policy paradigms (Biot and others 1995). The first is a classic approach which assumes

that technical solutions to land degradation are available and that the problem is implementation-related. The emphasis of this approach has been on technical fixes and expert opinions, and little merit has been attached to local land users' practices and participation (Clay and Schaffer 1984). The second paradigm, often referred to as populist, links poverty and environmental degradation. It emphasizes the participation of local people by using their knowledge and practices as a guide for policy and action (Chambers 1983; Blaikie and Brookfield 1987; Mascarenhas and others 1991; Richards 1985; Hudson 1991).

The third approach, often called neo-liberal, draws from both the classic and populist approaches. From the classic approach, it takes the idea that technology to control land degradation exists, and from the populist approach, it borrows the notion of empowerment of the people. It then argues that the major degradative causes are institutional failures, and the lack of adequate incentives for the adoption of appropriate conservation technologies among land resource users (Binswanger 1989; Repetto and Gillis 1988; World Bank 1992). Many soil conservation and land reclamation projects have been influenced by the classic approach, which has often resulted in conflict between technology and local farming and socioeconomic conditions.

Official and local land users often have different perceptions about the land degradation problem. This continues to be a serious impediment to successful land degradation control projects (Blaikie and Brookfield 1987; Fortman 1989; Biot, Lambert, and Perkins 1991). A great deal of literature supports the idea that indigenous knowledge and practice are often well-informed and should be seriously considered in the development of technologies and intervention measures to address land degradation (Chambers, Pacey, and Thrupp, 1989; Fujisaka 1989; Toulmin 1991; Huijsman and Savenije 1991; Critchely, Reij, and Willcocks 1994; Sconnes 1993; Kruger and others 1995). While the official view is drawn from references to the little data available (often derived from science), farmers' views are based upon their observations, values, and experiences. These factors help them to interpret changes on indicators of soil and land degradation and to make decisions about specific actions.

Land degradation symptoms must be seen within the political, institutional and socioeconomic forces under which local land users operate. The "short-time horizon" of the poor is often due to policy and institutional failures such as absence of clearly defined property rights, limited access to markets and credit, and lack of safety nets. For example, the drought and environmental crisis in SSA in the 1980s is partly attributed to high military spending, government-dominated marketing and distribution systems that squeezed the surplus from peasants, and inappropriate land and forest management policies which stifled incentives for production and protection of the environment (Timberlake 1986). Such broader analysis offers deeper insights into the land degradation problem, suggesting appropriate policy measures that should be applied before the process becomes irreversible. The cost of rehabilitating already degraded land is prohibitively expensive -- about ten to fifty times higher than that of preventive measures taken at an earlier stage (World Bank 1992).

The interpretation of change in some indicators, and the assessment of its impact on land resources, adds to the perception gap. For example, there is a common assumption among officials that land degradation is widespread. This perception is not shared by local land users. Local technical knowledge is based on experience and tradition, and has low risks and external inputs. It is accumulated slowly and cannot keep pace with changes that impact the farming system (Ravnborg 1992). Thus, enhancing farmers' ability to interpret changes according to the new circumstance, and improving local knowledge and integrating it with scientific knowledge, is a significant challenge.

Soil and land degradation has diverse effects on individual farmers, local communities, society, economic activity, and the environment (Hurni 1996; Glantz 1987; Brown and Wolf 1985). This study will present various options that could bring positive synergies to restore soil productivity, enhance food security, and avert the vicious cycle of poverty and natural resource degradation. Some of the key elements will include: (a) technical innovation based on proven practices and indigenous knowledge, e.g. increasing biomass production through intercropping, manure, composting, minimum tillage, agroforestry, improved soil cover and moisture management, strip cropping, contour tillage and planting, low-cost erosion control and soil conservation techniques; (b) enabling policies, e.g. pricing policy, fertilizer subsidy, incentives to ensure farm-level profitability; (c) institutional capacity, e.g. extension service, local organization, land tenure and conflict management, and data generation and reporting; (d) implication for policies and investment programs; and (e) priority areas of research to restore soil productivity and increase food security.

Policies and actions to address land degradation are enacted at various levels (farm, community, district, regional, national, and international). Most conservation and land resource management projects are initiated, administered, and managed at the district level (Izac and Swift 1994; Pieri and others 1995). The success of such investment programs partly depends on capacity and effective management at the district and village level. The most significant linkage between levels of productivity and land quality is observed at the village level where local land users take decisions on cropping and livestock management, with these decisions having a direct impact on land productivity. Insights about farmer perceptions about land degradation, response to changes, technologies and best practices, and indigenous knowledge are gained at the village level. Understanding the dynamics of these interactions at the village and farm level enhances the success of policies and programs to address land degradation. Hence, the level of intervention selected for this study is at the district and village level.

Because land degradation is influenced by local ecological and socioeconomic forces operating in a society (Spooner and Mann 1982; Chambers 1983; Watts 1985; Blaikie 1982; Hare 1985; Anderson and Grove 1987; Little and Horowitz 1987; Dejene 1990; Biot and others 1995), the study tries to examine this complex process (in Chapters 2, 3 and 4) through case studies at the district and farm (village) level. The implementation of policies and projects to address land degradation has generally faced

serious difficulties at the farm level. Thus, by focusing on the farm and village level, this approach could help in diagnosing as well as finding more responsive solutions to local ecological and socio-cultural conditions. This approach could also facilitate the participation of local land users in policy formulation and help implement investment programs in land resources management.

Objectives of the Study

Understanding the land degradation process requires a deep understanding of local realities. Based on a systematic household survey, field observation, and interactions with farmers and local extension agents, this study has generated data on farmer perceptions of key land and soil degradation issues (such as soil erosion, soil fertility, livestock, farming practices, land tenure, land availability, and extension) affecting crop and livestock production.

The study examines farmer observations, interpretations of change indicators, and responses made by farmers to land and soil degradation. It also assesses the impact of farmer response on productivity and environmental sustainability. Such an analysis would enhance our understanding of both the local degradative and beneficial process, promote local participation, and help in the design of strategies, investment programs and projects to enhance soil fertility and food security. Furthermore, the analysis contributes to the general literature on land and soil degradation. This is essential to long-term progress because of the scarcity of primary data at the farm and household level to address land degradation.

The specific objectives of the study are to:

- examine farmer perceptions of land degradation, particularly their understanding and interpretations of factors and indicators related to soil erosion and soil fertility decline and the level of degradation of crop and pastureland;
- identify technologies, best practices and indigenous knowledge used by households to control erosion, enhance soil fertility, increase crop and livestock productivity among smallholders;
- assess the impact of cropping, tillage, livestock, land, and fuelwood management practices on soil productivity and the sustainability of the smallholder farming system;
- examine policies that could bring positive synergies to enhance soil productivity and food security, create incentives for intensification of the farming system, and control environmentally damaging land-use practices;
- examine the institutional capacity issues -- particularly land tenure, local organizations and participation, and extension service -- that promote strategies and activities to restore soil fertility, increase farm productivity, strengthen local organization, and improve the delivery of extension service; and

- contribute to better policies, investment programs, identification of priority areas of research, and understanding of the land degradation problem.

Chapters 2 and 3 present the farmers view of land degradation and provides insights about why local land users think and respond as they do. This could help narrow the perception gap between officials and local land users in diagnosing and finding solutions to the land degradation problem. These chapters also generate relevant information on the process, indicators and response to land degradation (at the district and farm level), and investigate the reasons for farmers adopting or not adopting recommended technologies.

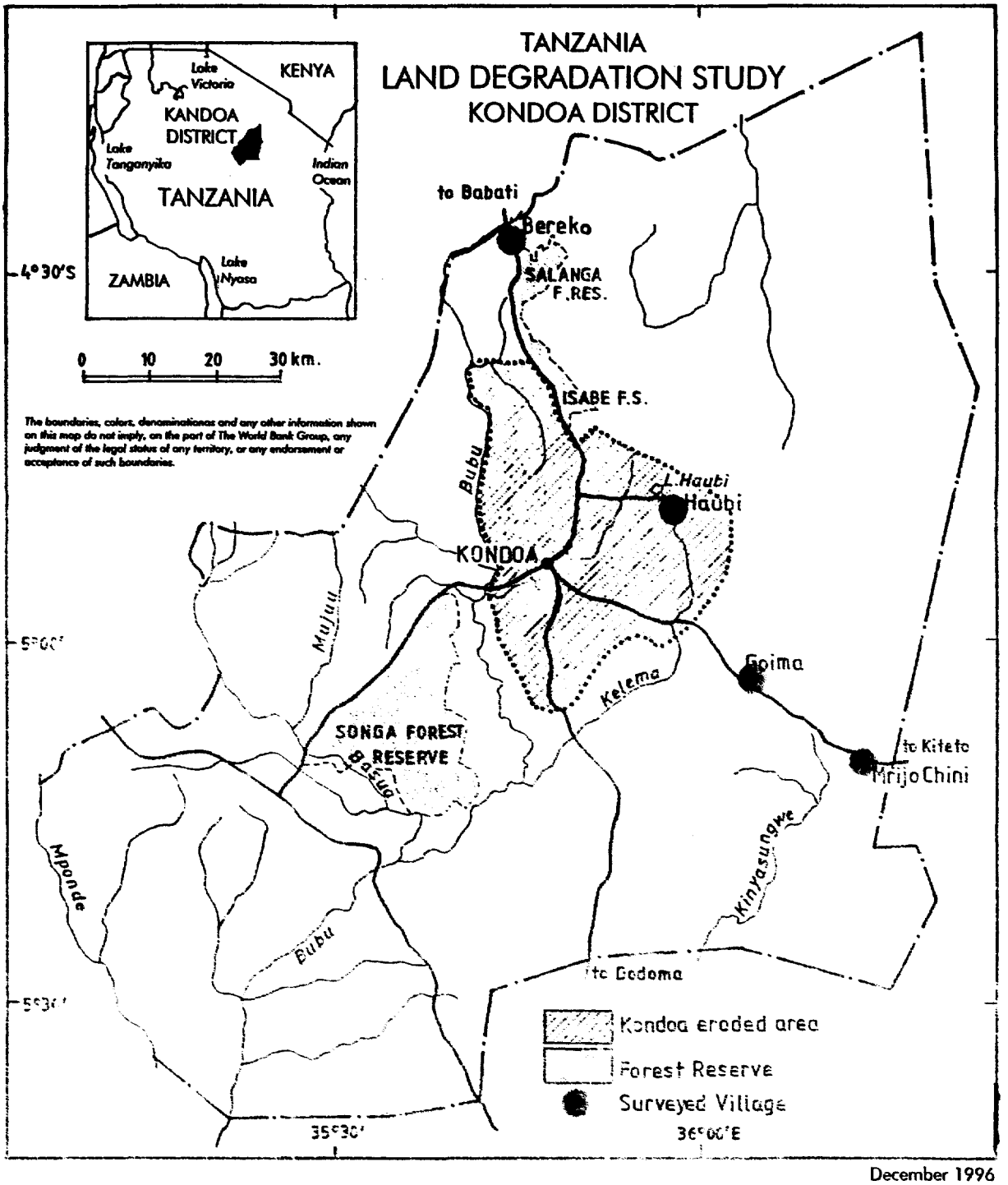
Policies affecting the use and availability of fertilizer and tree planting (agroforestry) are also presented in Chapter 2, while policies on water availability and the use of animal traction are discussed in Chapter 3. Chapter 4 discusses policies influencing land availability, extensification of agriculture through clearing of new land, land fragmentation, and land tenure and conflict. It also probes ways to build and incorporate sound indigenous technical knowledge as part of the recommended technical practices. The summary of the major findings with policy implications is presented in Chapter 5.

The Setting

The study was conducted in Kondoa District, located in Dodoma Region on the central plateau of Tanzania (Figure 1) between latitudes 4° 30' and 5° 36' south, and longitudes 35° 10' and 36° 27' east. It covers an area of 13,207 km^2 and has a population of 340,000 (67,797 household). Its population density is about 28 people per km^2 (Bureau of Statistics 1988). While this figure indicates no shortage of land in the district; the human and livestock population distribution in the district is uneven, owing to variations in rainfall and availability of suitable land for farming. The highland areas are more densely populated and more seriously affected by soil degradation than the surrounding plains.

According to the Ministry of Tourism, Natural Resources, and Environment, which has a leading role in defining the National Environmental Policy, land degradation is a serious problem in Tanzania (Ministry of Tourism, Natural Resource and Environment 1994). This problem is more serious for land used by smallholders and agro-pastoralists in semi-arid areas such as Kondoa District. Of the 94.3 million ha of surface area of mainland Tanzania, smallholders utilize some 5 million ha in crops, pasture and forest. About 22 million ha of land (23 percent of the total area) are allocated for reserves. This is the largest share of land resources allocated for reserves in Sub-Saharan Africa. Agricultural land with good cropping potential is estimated at approximately 10 million ha (6.5 million ha outside reserves and another 3 to 4 million ha

IBRD 28476



December 1996

within reserves), while areas actually under crop are estimated to be 3.5 million ha. About 85 percent of the cultivated area is used for food crops requiring good land husbandry conditions (World Bank 1994).

With the rural population growing at 2.6 percent annually, agricultural expansion is a viable option for smallholders to address population pressure and declining productivity in most areas of Tanzania. However, in areas where rainfall pattern is variable and inadequate, and soil poor (as is often the case in Kondoa District, which is mostly semi-arid), bringing new land into subsistence production, without improved crop and animal husbandry practice, damages land resources. It can also undermine the sustainability of smallholder farming systems.

Rainfall in Kondoa District is generally low and unreliable. In addition, Kondoa District has one of the highest rates of evapotranspiration in the country (1,500 mm/year). Rainfall comes from highly erosive storms which arrive when the protective crop/vegetation cover is at its sparsest. For example, 70 percent of the erosive rains occur in the thirty days after the onset of the rainy season, when the soil surface is sparsely covered with vegetation (Moore 1979). This underscores the severity of soil erosion in certain localities.

There are two marked seasons: the hot dry season (June to November), and the cool wet season (December to May). During the hot dry season, domestic and livestock water supplies in the district become so scarce that people must travel long distances in search of water. The main sources of water supply at this time of the year are from the few boreholes, earth dams (locally known as "charcos"), and shallow dug-out wells on dry sand rivers. Concentration of livestock at these water source points is a major cause of land degradation (see for example Murray-Rust 1972 and Christiansson 1981).

There are a number of forest reserves and government and mission-owned forest plantations in Kondoa District, particularly in the highlands. Most of the forest reserves comprise of woodlands, except for the one closed forest at Kome. Until the early 1970s, Kondoa District had been the main source of timber in Dodoma Region, which accelerated deforestation and soil erosion in the Kondoa hills.

Most of the people in Kondoa District are engaged in agriculture and animal husbandry for their livelihood. Indeed, the non-farm population is negligible, and even those residing in the urban areas may be indirectly engaged in agriculture, mainly through the distribution of agricultural products.

On the whole, Kondoa District can be divided into two main agro-ecological zones: (a) the Kondoa Hills and (b) the Surrounding Plains.

The Kondoa Hills

This zone extends northwards from the centre of the district and is comprised of the Kondoa Eroded Area (KEA). This is probably the most eroded part of the country, and has been subject to several soil and water conservation schemes. The zone is rolling to hilly, and dissected by several fault scarps, with numerous tributaries of the Bubo and Kelema rivers. The zone lies between 1,000 and 1500 m above sea level. It is relatively wet with rainfall of over 750 mm/year and features of sub-humid areas. The soil are generally less fertile and intensively cultivated and more vulnerable to erosion because of relief (Payton and others 1992).

The current vegetation in the Kondoa Irangi Hills are mainly forms of degraded savanna composed of degraded low tree and shrub savanna and degraded savanna woodland (miombo), often comprised of low bushland or regenerating scrubs, and (locally) semi-evergreen montane forest. The degraded low tree and shrub savanna is found in the drier parts of the area in the southwest, dominated by *Acacia sp.* The degraded savanna woodland is commonly found on moderate slopes, particularly in more moist north and northeast, with a dominance of *Brachystegia sp.* The semi-evergreen forest covers the elevated slopes in the northeast.

The Kondoa hills zone can be further sub-divided with reference to the physiographic and ecological details into:

(i) the more dissected terrain in the south, which is represented by Haubi village in the study; and
(ii) the less severely eroded hilly terrain in the north which, in this study, is represented by Bereko.

Surrounding Plains

This zone consists of an undulating plain, with a few isolated hills and some large swamps. It is generally dry (rainfall below 700 mm/year) with relatively fertile soil, lying between 500 and 1,200 m above sea level. The geology of the area is more similar to the Kondoa Hills zone. According to Conyers (1971), this zone is an area of relatively recent settlement (since the 1940s) with people from the Kondoa highlands still moving into the area.

Similarly, this zone may be sub-divided into two sub-zones:

(i) the dominant livestock-keeping area as represented by Goima village; and
(ii) the dominant extensive crop production area represented by Mrijo Chini.

Some of the key physical, ecological, and socio-economic features of the two sample villages representing the Kondoa hills are presented below.

Haubi village

- Dissected terrain with severe water erosion features. This is in the Kondoa Hills and lies between 1000 - 1500 m above sea level. Cultivation takes place in the infertile sandy alluvial soils and sandy river valleys. This is necessary because the pediments are dissected by erosion. Average annual rainfall in Haubi is about 900 mm. Typical soil is shallow, stony and not suited for cultivation. These are remnants of ancient soils on slopes, which are presently uncultivated because of erosion. There are bleached sands and loamy sands which developed from a colluvium of foot slopes and cracking clays (vertisols) and are infertile.
- Old settlement areas where agro-pastoralism (integrated cropping and livestock activity) has been the dominant farming system for centuries. High population and livestock pressure have resulted in severe land degradation which prompted the introduction of government-supported conservation measures (including destocking of livestock from the village in 1979).
- A serious land shortage leading to expansion in marginal areas within the village, and outward migration to the surrounding plains.

Bereko village

- This area has a topography similar to the Haubi area but without the severe water erosion features. There are sandy alluvial fans and sandy river valleys. Cropping and livestock are well integrated into the farming system, but the area is not destocked.
- Average annual rainfall in Bereko is 750 mm.
- The typical soil profile resembles that of Haubi, but cultivation is mainly practiced in the pediment and footslopes which are relatively more fertile and not as highly eroded as Haubi.
- Increasing land shortage due to population growth within an area confined by forest reserves; and incipient soil erosion because of increasing deforestation.

Similarly, the key physical, ecological, and socio-economic features of the two sample villages representing the surrounding plains are presented below.

Goima village

- Gently undulating to rolling plain surfaces at an altitude between 500-1200 m above sea level (referred to as Masai Plains).
- Physical properties of the soils on the crests and pediments slopes which resemble those of Bereko.
- There are expansion areas on the dry Masai Plains where the displaced livestock from the Kondoa destocked area (represented by Haubi) were to be sent. While agro-pastoralism is practiced, livestock rearing is more dominant. Soil erosion features are increasingly evident, indicating the unsustainability of the farming practice.

Mrijo Chini

- More flat and represents the other variant of the Masai Plains which occurs within the same latitudinal range as Goima.
- Soils are similar to those of Goima, but with wider topographic depressions occupied by readily cultivable soils developed from young alluvium.
- Represents an expansion area on the drier Masai Plains with extensive cultivation and seasonal migration influx. Migrants may originate from far away (as far as Singida and Arusha).
- Large-scale farming involving cash crops is widespread. Cropping is the main activity.

Table 1: Highlights of key ecological and socio-economic characteristics of sample villages in the study area
(April 1997)

Key Ecological and Socioeconomic Characteristics	*Name of Selected Villages*			
	Haubi	Bereko	Goima	Mrijo Chini
Topography	• Hilly with dissected terrain • 1000-1500 m above sea level	• Hilly area surrounded by forest reserve • Similar altitude as Haubi	• Rolling Masai plain • 500 - 1200 m above sea level	• Flatter type of Masai plain • Relatively similar altitude to Goima
Level of erosion	• Noticeable severe erosion features such as gullies	• Moderate erosion features	• Severe erosion features	• Moderate erosion features
Land scarcity	• High	• High	• Limited	• None
Population density	• High	• High	• Low	• Low
Type and scale of farming	• Traditionally mixed farming but more emphasis on cropping after destocking • Smallholders	• Predominantly crop farming • Smallholders	• Agropastoral with emphasis on livestock • Considerable number of pastoralists	• Predominantly crop farming by large-scale operators • Some of the land used by pastoralists
Settlement pattern	• Very old settlement and cultural area	• Moderately old	• Newly opened area by settlers from densely populated areas particularly Haubi	• Newly cleared land due to agricultural expansion mainly by large-scale farmers
Use of chemical fertilizer	• Moderate use of chemical fertilizer even after elimination of subsidy	• Currently very limited but considerable use before elimination of subsidy	• Almost none	• Almost none
Use of organic fertilizer	• High-level use	• High-level use	• Limited use	• Limited use
Conservation practices	• High level of involvement	• High level of involvement	• Limited level of involvement	• Limited level of involvement

Source: Authors', 1997

Methodology of the Study

The major land degradation issues affecting Tanzania were identified and discussed at a technical workshop organized by the Institute of Resource Assessment, University of Dar-Es-salaam. The workshop was held in January 1996 in Dar-Es-salaam, and involved a multidisciplinary group of local experts representing key government agencies, national agricultural and livestock research institutes, regional and district level agricultural and livestock officers, NGOs, middle-level land use and conservation managers, and scientists.

Participants at the technical workshop identified the land degradation issues affecting the various agro-ecological zones in Tanzania. The participants' inputs focused on the most serious problems of small farmers and herders in the largely semi-arid area of Kondoa District where the field study was conducted. These major land degradation issues include soil erosion, soil fertility, land availability, farming practices, livestock, land ownership, household energy, and institutional capacity.

A case study approach helps to contextualize the physical, biological, and socio-economic factors that cause land degradation in a particular locality. Kondoa district was selected as a case study for the following reasons:

(a) it represented the more severely degraded areas of Tanzania with widespread poverty and frequent food shortages;
(b) the district was relatively accessible to conduct field work with limited financial resources and time constraints; and
(c) there are ongoing activities addressing the issue of land degradation in this area which could provide some data/information for the present research to build upon.

Taking Kondoa District as a case study, a survey questionnaire was used to gather primary household data at the village level. The questionnaire was prepared, pre-tested and administered by the field investigating research team (Dejene, Shishira, and Yanda). Primary data was also generated by interviewing local extension agents and through field observation and verification by the same team.

Both stratified and random sampling approaches were used to collect primary data on the major ecological and socio-economic causes of land degradation identified during the technical workshop (see Appendix A). Intensive fieldwork within the Kondoa District was concentrated in four villages carefully chosen through stratified sampling based on the major ecological zones of the district. The villages representing the various agro-ecological zones were selected by expert opinion including local farmers, local extension agents, agricultural officers, livestock officers, and IRA staff members with extensive experience and knowledge of the area. Through this process, the four villages -- namely Haubi, Bereko, Goima, and Mrijo Chini -- were selected to represent the major socio-economic strata and agro-ecological zones in the Kondoa District. The total

number of households for Haubi village is 1106, for Bereko 931, Goima, 488, and Mrijo Chini, 311.

Households in each village were interviewed through random sampling. In order to minimize gender biases, both husbands and wives were encouraged to respond to the questions. Since the questionnaire did not aim to gather information on gender sensitive issues such as income, the assertion that women may not offer factual information in front of their husbands was not an issue. Fifty households were interviewed in each village. The sample size is adequate to provide policy-relevant insights and answers to the main objective of the study, without involving large-scale survey and rigorous statistical analysis (Cernea 1985). The field investigating research team felt that the combination of stratified and random sampling was appropriate for this study and would generate reliable information in a cost-effective way.

To enhance the participation of local communities and to gain the confidence of farmers, as well as for logistical purposes, the actual household questionnaire work in the field was done largely with the assistance of extension agents living among the farmers. A concerted effort was made to verify the information gathered through the survey questionnaire by making field observations and cross-checking with local extension staff. The survey questionnaire was translated into Swahili, and a one-day seminar was held in the field in order to familiarize field interviewers with the objective of the study and the questionnaire. The questionnaire was pre-tested during the first week of February 1996, and necessary adjustments were made in the second week of February 1996 in Kondoa District. The data collection in the four villages was undertaken from the middle of February 1996 to the first week of April 1996. Most of the statistical analysis of the data was done from July 1996 to September 1996 in Dar-es-Salaam.

CHAPTER 2

SOIL DEGRADATION

Soil degradation commonly manifests itself through soil erosion and soil fertility decline. Tanzania is one of the developing countries increasingly affected by these two forms of soil degradation. Indeed, all the major agro-ecological zones encounter this problem, with varying intensity. The semi-arid areas such as Kondoa District are particularly vulnerable to these kinds of soil degradation, given the inherent low soil fertility, low productivity, unreliable rainfall, and improper land and livestock practices. The majority of the people who work these lands are agro-pastoralists, who depend on subsistence agriculture and cattle.

Soil degradation in Tanzania has been a growing concern since the late 1920s when evidence of soil erosion, such as gullies, were first observed in many parts of Central Tanzania (Gillman 1930). Initial efforts to understand the process focus on the collection of quantitative data on run-off and soil loss (Staples 1936, 1939; Van Rensburg 1955). Other studies on the assessment of soil erosion (e.g. Gillman 1933, 1934; Rapp and others 1972) collected data on reservoir sedimentation and sediment yield in selected catchments in Tanzania.

These studies showed that improper cultivation practices, deforestation, and overgrazing are the major causes of soil degradation in the semi-arid parts of central Tanzania (Rapp, Berry and Temple 1973). They also illustrated the nature of the problem and the need to take action. Consequently, the ongoing Hifadhi Ardhi Dodoma (HADO) - Dodoma Soil Conservation Project was initiated in 1973. The project promotes soil conservation practices, conservation of grazing land, stabilization of gullies, destocking, afforestation, and education. The project is implemented by the Government of Tanzania with the support of the Swedish International Development Authority (SIDA).

SOIL EROSION

Most farmers in Kondoa District are aware of soil erosion on their land (Table 2).

Table 2: Farmers' awareness of the existence of soil erosion on their land

Village	*Yes (%)*	*No (%)*	*Total (%)*
Goima	90	10	100
Haubi	82	18	100
Bereko	72	28	100
Mrijo Chini	70	30	100

Source: Authors' data, 1997

The highest number of farmers reporting an awareness of soil erosion on their fields was in Goima (Table 2). However, based on field observation and discussion with local extension agents, the level of awareness should have been highest in Haubi, followed by Goima, Bereko, and Mrijo Chini. The higher percentage of awareness in Goima as compared to Haubi is most likely because Goima is a relatively new settlement area and most of the accelerated soil erosion processes may be taking place only now. Most people in Goima moved from the Kondoa Eroded Area because of the destocking measures introduced by the government in 1979. In contrast, Haubi is an old settlement area and farmers in Haubi may feel that erosion and badlands are a part of their landscape.

Development of gullies and rill and top soil erosion due to rain are the common indicators acknowledged by a considerable number of farmers in all the villages. Farmers also reported other soil erosion indicators such as exposure of roots, deposition of sediments on the farm, color change of crop leaves, soil becoming reddish or sandy, and increased water run-off in the fields. But there was variation from one village to another in the number of farmers acknowledging these indicators. For example, soil becoming reddish and the color change of crop leaves were only acknowledged as indicators in Goima.

A significantly higher proportion of farmers in Goima (72 percent) reported the development of gullies. This is more than for any other village including Haubi (36 percent). This again suggests that farmers may recognize the degradative process more in Goima than any other village. Awareness, however, has not resulted in action to address the problem in Goima since field validation showed that most farmers are not actually practicing soil conservation measures. This might be attributed to the negative attitude most farmers have towards conservation measures, many of which have forced them to move into areas (such as Goima itself) where conservation is not enforced. It could also be explained by the affordability factor since conservation may require capital or labor investment.

The overwhelming majority of farmers in the study area (Bereko, 100 percent; Haubi, 98 percent; and Goima, 76 percent; with the exception of Mrijo Chini 28 percent), reported practicing some type of conservation measure to deal with soil erosion (Table 2). However, these responses have to be examined cautiously since a cross-examination during field work of the soil conservation measures that farmers indicated they were practicing, showed that these responses were exaggerated in some villages -- perhaps for good reason. Still, people in the Bereko and Haubi have been influenced for more than two decades by various land conservation schemes which were initiated by central authorities and supported by donor agencies. Examples of such schemes are the Dodoma Soil Conservation Project (HADO) and the Integrated Rural Development Program (IRDP) in Kondoa District.

Table 3: Types of soil erosion control measures being practiced

Types of measures	*Haubi (%)*	*Goima (%)*	*Bereko (%)*	*Mrijo Chini (%)*
Cultivation along contour	5	76	30	2
Terracing	84	4	6	10
Strip-cropping along contour	84	10	100	0
Bunding	32	0	6	6
Wind-breaks	42	19	40	2
Vegetation and crop cover	32	2	4	0
Grasses waterway	24	34	16	0
Tree Planting	14	10	42	0
Re-fill rills and gullies	0	8	0	0
Construction of check dams	0	0	32	12
Planting hedges on field boundaries	0	0	2	0

Source: Authors' data, 1997

There was a discrepancy between farmers' responses as indicated in Table 3 and field validations by the core investigating team. The proper verification of farmers' response has enhanced the reliability of survey data. For example, terracing is reported to be widespread in Haubi. In fact, terracing in the proper sense is seldom seen in Haubi village. Since terracing is one of the technical packages recommended by HADO, most farmers would not like to admit not practicing it. The cost of terracing, particularly in terms of labor, is high, and there is a labor shortage in many of these villages. Depending on the type of terrace, a study in Kenya has shown that it could require 50 - 400 man days/ha for construction and 5 - 72 man days/ha for maintenance (Kassam and others 1993). Instead of terraces, the field investigating team observed bunded fields, which involves putting crop residue along the contour as well as raised beds around Lake Haubi area, which are meant to protect fields from waterlogging.

On the other hand, many farmers in Haubi dig trenches along contours, which for practical purposes serves as check dams to trap sediments and run-off. Farmers may have overlooked reporting these conservation measurers in Table 3 because these trenches once constructed could last up to ten years. There is also widespread cultivation along the contours in Haubi, particularly where draft power is used as reported in Table 3.

Similarly, observations revealed that the high number of respondents practicing conservation measures in Goima does not correspond to actual field observation or discussions with local extension agents. For example, cultivation along contours is not as widespread in Goima as reported by farmers in Table 3. It seems that Goima farmers may have been untruthful in responding to this question. This does not mean, however,

that they were unreasonable, since farmers in general are suspicious in giving information which they fear can be used against them. Admitting to not practicing conservation measures enforced in the Kondoa Eroded Area (where most of them originally came from) by HADO is to admit to transferring the degradation process to a new area. This is likely to invite unpopular measures such as destocking, which may force them to move again to another area.

Farmers are also aware of plant species that signify the severity of soil erosion. The following plant species are identified by vernacular names: Lumumbu, Irenda, Nyafybyafu, Mbigiri, Ngolo, Ifumdankuku, Malungulu, Ifefere, Chilori, Sorghum hymathica, Songeya, Monilankumbi, and Ngumbea. The plant species indicators are, however, site-specific, and their significance as indicators may be applicable only within a specific locality. For example, in Bereko, 32 percent of the farmers cited *Sorghum hymathica* as an indicator, while this species was not reported in Haubi, Goima and Mrijo Chini. The findings also revealed that the largest number of farmers aware of plant species indicators are in Bereko, followed by Haubi, and then Goima and Mrijo Chini. This could be because most of the people in Goima and Mrijo Chini have only recently moved to the area and are thus not as knowledgeable about local plants.

It would seem that the more information there is regarding plant indicators in an area, the easier it would be for local key informers (particularly elderly people) to identify them. For example, in Haubi, one key informer pointed out that two plant species, Kinyafunyafu (Rhynchelytrum repens) and Mjirojiro (Chrysanthemoides monilifera) indicated an extreme stage of erosion. In cross-checking it was confirmed that indeed these species grew on sub-soil on heavily eroded pediment surfaces and along gully margins. This shows a wealth of local knowledge which can be tapped and utilized in the development of reliable plant indicators.

In fact, through a quick consultation with a few key informants, the following list of plant indicators of soil degradation were identified (Table 4).

Table 4: Vegetation specimen collected from Kondoa Irangi Hills indicating different levels of soil degradation

No.	*Species Names*	*Vernacular Names (Ki-rangi)*	*Family Names*	*Indicator Description*
1	Ocimum basilicum	Idumbasi	LABIATAE	Plant not eaten by animals and consequently dominates in overgrazed areas.
2	Oxygonum stuhlmannii	Mbigiri	POLYGONACEAE	Appearance of the plant in a farm indicates beginning of decline in soil fertility.
3	Tagetes minuta.	Bangibangi	COMPOSITAE	Grows on exhausted soils.
4	Dipcadi longifolium	Inyerya	LILIACEAE	Indicates soil exhaustion. Occur mainly on sandy soils.
5	Sesamum angustifolia	Mlenda	BORAGINACEAE	Indicates decline in soil fertility.
6	Wahlenbergia denticulate	Kinyamsongo	CAMPANULACEAE	Indicates decline in soil fertility.
7	Vernonia lasiopus	Ngolo	CURCUBITACEAE	Indicates poor soil fertility. Occurs on sandy soils.
8	Melinis repens	Kinyafunyafu	GRAMINEAE	Occurs on heavily eroded surfaces. Indicates extreme soil erosion. Grows well on the sub-soil - mainly along gully margins on pediment and on rocky sites.
9	Chrysanthemoides monilifera	Mjirojiro	COMPOSITAE	Occurs on heavily degraded gully sides on pediment slopes as in the case of all the above species.
10	Conyza pyrrhopappa	Msongorera	COMPOSITAE	Medicinal plant. Occurs on argillic horizon on similar sites to species 8 and 9. above. Unpalatable plant species growing on cultivated land or around biomass.
11	Spermacose senensis	Njulai/Lukalanga	RUBIACEAE	A weed which spreads quickly, difficult to eradicate, and rapidly depletes fertility around the area it grows.
12	?	Chiloki	GRAMINAE	Indicates extreme lack of fertility, and may indicate poor land management and lack of inputs.
13	Bidens pilosa	Mpumbugi	COMPOSITAE	Indicates fertility deficiency.
14	Vernonia glabra	Ipuma	COMPOSITAE	Indicator of high soil fertility. Often occur s on termite mounds.
15	Clerodendrum rotundifolium	Ifiwi	VERBENACEAE	Indicator of high soil fertility. Often occurs on termite mounds.
16	Hibiscus sp.	Choya	MALVACEAE	Occurs on sand fans.
17	Digitaria sp.	Kivumba	GRAMINAE	Occurs on pediment and sand fans.
18	Indigofera cuniata	Kirima sengo (Fagio)	PAPILIONACEAE	Occurs on sand fans.
19	Mellines repreis	Ijenga nche		Occurs on pediment and sand fans.
20	?	Lumumbu		Occurs on sand fans.

Source: Authors', 1997

Farmers are aware of the emergence of unpalatable plant species signifying the degradation of pasture land. The following plant species were given by vernacular names, Ibangi, Idumbasi, Kikokora, Mpumbuji, Kurivariva, Manyauki, Ijenganchee, Ikindu, Isinjavudu, Hadai, Athaigumachuchi, Chekenchela, Gugutho, Kuruwiri, Manaye, Lushinde, and Injenkambi. Similar to the observation made regarding plant species signalling soil erosion, most of the above plant species were not reported in more than one village. One of the few exceptions is Ibangi which was reported in Haubi and Mrijo Chini. Again, this suggests that plant species indicators are site-specific.

With respect to the level of stoniness as an indicator of soil erosion, the majority of farmers in all four villages felt that there was no change in the level of stoniness on their farms, suggesting that the level of stoniness is not a good indicator in these localities. This is largely because most of the stones are found on uncultivated hilltops. Most cultivation is now concentrated on lower pediment and sandy alluvial deposit areas. In some areas, notably Goima and Haubi village, a few farmers pointed out that exposure of roots, deposition of sediments in the farms, and exposure of subsoil are indicators which signify the severity of erosion .

Soil Fertility

Soil fertility refers to the availability of plant nutrients (particularly N, P, and K) and soil organic matter in the soil. Soil fertility decline occurs when the use of soil nutrients exceeds their replenishment. Most soils in SSA have a low nutrient content (particularly in nitrogen and phosphorus) and a low level of soil organic matter. Soil degradation results in the depletion of these nutrients and loss of soil organic matter. Net nutrient removal exceeds replenishment by a factor of 3 to 4 in many Sub-Saharan countries (Stoorvogel and Smaling 1990). This is considered one of the major reasons for a decline in food production in these countries (Yates and Kiss 1992; Borlaug and Dowswell 1994; Sanchez and Leaky 1996; IFPRI 1996). Part of the reason for soil nutrient loss is a very low use of mineral fertilizer, estimated at 10 kg/ha per hectare in SSA, the lowest in the developing world (Bumb 1995).

Similarly, most smallholder farming systems in Tanzania do not use adequate external inputs to compensate for the loss. Although there is no available data on soil fertility, nutrient loss on smallholder farms is believed to be considerable. There is also no major improvement in farm and land management practices to avert this trend. This is even more the case in the study area, which is mostly in semi-arid zones and has low natural fertility.

Table 5: Farmers perceptions' of soil fertility decline

Villages	*Yes (%)*	*No (%)*	*No Answer (%)*	*Total (%)*
Haubi	84	14	2	100
Goima	70	30	0	100
Bereko	66	34	0	100
Mrijo Chini	62	36	2	100

Source: Authors' data, 1997

A decline in soil fertility was a common problem in all the case study villages (Table 5). This finding is similar to the Oxford University and Sokoine University study which showed that farmers in all the major farming systems experienced a marginal decline in soil fertility (Oxford University and Sokoine University Vol. 1, 1992).

An important finding of the study is that the practice of fallowing is virtually absent in all villages. In Haubi and Bereko, this reflects an acute shortage of land which has led to a continuous cultivation of the same plot. Without external inputs for soil replenishment, and in the absence of soil conservation practices to restore and maintain soil fertility, the lack of fallowing results in overcultivation and soil fertility decline. A study conducted in Haubi village and Dodoma District has also revealed that most plots are cultivated every year, without fallow, and are subject to a significant loss in soil fertility (Mohamed 1996; Oxford University and Sokoine University Vol. 2, 1992)

The most commonly-cited indicator of soil fertility decline is a decrease in crop yields. The majority of farmers in Haubi (88 percent), followed by Goima (84 percent), Mrijo Chini (76 percent), and Bereko (64 percent) pointed out that a decrease in crop yield is a significant indicator of soil fertility decline. Crop yield is often used as a proxy measure for land degradation among officials and experts. Other indicators mentioned by farmers include, crop leaves becoming yellow, crops becoming stunted, weeds, termite mounds, and disappearance of grass and palatable species.

Farmers are also aware of the existence of plant species which signify soil fertility decline. The following plant species are identified by their vernacular names: Irenda, Iduma, Kilimilasengo, Kanga, Mbigiri, Mabangi, Ijenganichee, Inyeri, Mchoya, Lumubu, Kivumba, Nzolai, Kinyasanga, Chilori, Thathauri, Tutukuru, Ghachananuu, Rangaranga, and Ilugulu. Some of these plant species indicators are also cited as signifying a high incidence of erosion. For example, some farmers identifed Irenda (in Haubi), Mbigiri (in Bereko and Haubi), Chilori (in Goima) as signifying both soil erosion and a decline in soil fertility.

As with soil erosion indicators, the plant species indicating soil fertility decline are site-specific. An effort should be made to tap into indigenous knowledge regarding

indicator plant species and by working with key informants. Most respondents in Bereko cited *Sorrghum hymathica* as an indicator of soil infertility, and this was confirmed through discussions with local extension agents. The extension agent informed us that *Sorrghum hymathica* is truly an indicator of soil fertility decline: whenever it colonizes, a severe loss of soil nutrients follows.

Farmers consider termite mounds as indicators of high levels of soil fertility (Table 6). Hence, they cultivate selectively around these mounds to grow food crops (Yanda 1995). Such practices are more concentrated in the Kondoa Eroded Area where hilltops and hill slopes are covered by closely-spaced termite mounds. Even though farmers in Haubi have not reported cultivating around termite mounds, as in Bereko (Table 6), the investigating team observed during the field work, some farmers are involved in such a practice. It was beyond the objective of this study to investigate the soil characteristics of termite mounds, but other studies have analyzed soil samples from termite mounds in similar environments (Dodoma area). These studies showed that the soil is rich in phosphorus, has a suitable acidity level, and has high exchangeable bases, enhancing the soil organic content (Johansson and Strömquist 1977).

Most farmers are taking various measures to improve soil fertility. Those villages which indicated high participation in soil erosion control were the same villages which indicated high involvement in soil fertility restoration, with Haubi (94 percent) and Bereko (92 percent) at one extreme, and Goima (58 percent) and Mrijo (38 percent) at the other. Field observations by the investigating team also corroborated that most of the fields (shambas) in Haubi and Bereko were well-maintained. Farmers in these two villages were also systematically using compost manure and cow dung to enrich fertility. One of the reasons is the ongoing land management/conservation schemes in the area, which have also influenced the widespread use of soil conservation practices, as discussed earlier under soil erosion (e.g. HADO).

Table 6: Soil fertility enriching practices

Practices	*Haubi (%)*	*Goima (%)*	*Bereko (%)*	*Mrijo Chini (%)*
Intercropping	32	2	10	22
Use of inorganic fertilizers	36	2	0	0
Use of compost manure/ploughing in crop residue	66	2	22	0
Use of farm-yard manure	54	62	86	38
Agroforestry	4	6	38	0
Cultivating around termite mounds	0	0	8	0

Source: Authors' data, 1997

Table 6 shows that more farmers in Haubi and Bereko are taking measures to maintain soil fertility. This could be partly be due to the influence of ongoing land management/conservation schemes (such as HADO). But a more significant explanation is the increasing population density and scarcity of land in Haubi and Bereko. There is a linkage between high population density and incentives to improve soil productivity, since investment in soil fertility-enhancing measures to maintain productivity becomes more rewarding and profitable as the scarcity value of land increases with respect to labor. Similarly, more farmers in Haubi and Bereko are using oxen ploughs (Table 7) and making investments in their land (Chapter 4). These findings suggest that high rural population density could lead to a greater incentive to improve soil productivity, and tends to support the hypothesis that population growth could be a positive force towards intensification and land improvement technologies (Boserup 1981).

On the other hand, the majority of farmers in Mrijo Chini do not find investment in land rewarding. Nor do they take serious measures to increase soil fertility. This could be partly attributed to low population density and freely available land in the surrounding area. As described under the tillage system, many of the farmers in Mrijo Chini use heavy machinery to clear new land for ploughing. This is done more to increase efficiency than to improve the land. It is more profitable for these farmers to bring new land into cultivation, often in an environmentally damaging way, than to make an investment in existing land.

This study suggests that poverty can be a disincentive to undertaking soil and land improvement measures, resulting in the vicious cycle of poverty and natural resource degradation. Field observations and discussions with local extension agents determined that most farmers in Goima are relatively poor and operate in a more fragile environment. The majority of the respondents in Goima (64 percent), more than any other village, have

received government and outside assistance in times of food shortage. In addition, most respondents indicated that they perform casual labor to earn cash, often during the peak period of preparing the field for planting. As a result, they have little time to work and improve their own farms. These farms, as observed during field work, are actually affected by rill and gully erosion, and experience an accelerated loss of nutrients and organic matter.

A case study in Babati District, Tanzania, has shown a relationship between poverty and environmental degradation. Very poor households which must combine day labor with work on their own fields often have little time for second ploughing and timely weeding. Thus, they plant late, which adversely affects yields. A 50 percent difference in yield was observed between a field that is hastily ploughed and planted late with insufficient spacing, and one that is carefully ploughed twice and planted at the appropriate time with sufficient spacing (Lindberg 1996).

A poverty profile in Tanzania has also demonstrated a link between poverty and failure to invest in land. Fertilizer use was considerably higher among farmers above the poverty line (40 percent) as opposed to those below the poverty line (30 percent) (World Bank 1993). The Oxford and Sokoine University study underscored the link between poverty and land degradation by showing that the smallest number of farmers investing in land were in the agropastoralist production system, which consists of relatively poor farmers in marginal areas as compared to other higher potential areas in Tanzania (Oxford University and Sokoine University Vol. 2, 1992).

The use of inorganic fertilizer is an important input in the intensification process. Its proper use can replenish nutrients, enhance soil fertility and biomass, and increase crop yields. Fertilizer use in Tanzania is very low, with an average input level of about 1 kg/ha on agricultural land, and a total of 140,000 t fertilizer products per year (IFAD 1991). In addition, over 80 percent of the fertilizer goes to the high-potential Northern and Southern highland regions. Most farmers in Tanzania and the study area use fertilizer on maize which is the staple crop.

The use of chemical fertilizer in the study area is insignificant, except among some farmers of Haubi (36 percent), as indicated in Table 6. There was also a substantial decline in the amount of fertilizer sold in Kondoa District during the period 1990 - 1994 when subsidies were being phased out. For example, data for Kondoa district revealed that NPK fertilizer, which is used by many farmers during planting, has declined from 300 t in 1990/91 to 2 t in 1993/94. There was also a decline in use of two types of fertilizers (CAN and UREA) often used as top dressing, from 243 t in 1988/89 to 18 t in 1993/94.

Macro-economic factors, particularly pricing policy, which eliminated fertilizer subsidies, is a significant factor that has drastically reduced the use of inorganic fertilizer to smallholders. Before the elimination of the subsidy in 1990/91, the cost of a 50 kg bag of urea was Tanzanian shs. (Tz shs.) 3222 and NPK Tz shs. 3, 476. In 1994/95 after the

elimination of the subsidy, the cost of a 50 kg. bag of urea was Tz shs. 10,000, and NPK Tz shs. 11,000. A good example of the sharp decline in inorganic fertilizer due to the higher price is observed in Bereko, where, at present, no one is using it. Yet, more than any other village, all respondents in Bereko indicated that fertilizer is beneficial, and 80 percent have bought fertilizer in the past (see Chapter 4), and would use it again if the price was not prohibitive. Bereko has a favorable climate and rainfall pattern, and risk aversion has not been a major constraint in using fertilizer or improved seed.

The evidence points to the elimination of subsidies as the most significant factor in the dramatic decline of fertilizer use. During the period when the elimination of the subsidy was put into effect (1990-1994), fertilizer prices increased by 184 percent to 412 percent, depending on the kind of fertilizer (Bagachwa and others 1995). At the same time, the price that farmers get for maize has not increased as significantly (it is estimated to have risen between 30 percent and 90 percent). Fertilizer has clearly become too expensive and virtually out of reach for most farmers in Bereko.

This subsidy removal was taking place alongside the rapid devaluation of currency and the privatization of state-owned enterprise. This was part of an economic liberalization program. Experience from other countries taking similar measures show a drastic decline in fertilizer use. As a result, some have argued against the removal of subsidies during a period of macro-economic instability, especially during rapid devaluation (Bumb and Baanante 1996).

Discussions with local extension agents and a detailed study on farming practices in Haubi village (Mohamed 1995) suggest a widespread use of chemical fertilizer in Haubi prior to the elimination of subsidies in 1994. Most farmers in Haubi are not using fertilizer, citing its high price and its limited availability in local markets. Still, fertilizer use in Haubi is considerable (36 percent), while it is insignificant in other villages. Farmers in Haubi seem to rely on the use of inorganic fertilizer to maintain yields, since they have limited options in using farmyard manure (due to the removal of livestock). Some use it even at a high cost, since mineral fertilizer is essential to get any yield on some of the plots where the soil nutrients have been virtually depleted. But most farmers are using compost manure, which underscores the ingenious way farmers are counteracting the negative impact of destocking measures on soil fertility.

A widespread decline in fertilizer use was reported nationally as well as in Kondoa district after the removal of the subsidy. Fertilizer was no longer an affordable investment for farmers nor for local retailers who supply it to smallholders. In addition to the increase in fertilizer price, demand for fertilizer has been affected by the rapid withdrawal of the Tanzanian Fertilizer Corporation (TFC) from fertilizer distribution, again a result of the economic liberalization program. The TFC was the sole importer and distributor of fertilizer prior to 1992, and contracted private traders and retailers to distribute fertilizer, allowing a 15 percent profit margin. With the withdrawal of TFC from fertilizer distribution, many of the administrative and transportation costs had to be

recovered by retailers, thereby substantially reducing the profit margin and fertilizer availability, particularly to those farmers who lived far away from the towns.

There is growing evidence that state-owned enterprises (such as TFC) are inefficient in the marketing and distribution of fertilizer and that the private sector should play a more important role (Pinstrup-Andersen and Pandya-Lorch 1994; Bumb and Baanante 1996). The issue being debated is whether the transition to the private sector should be gradual or rapid. In Tanzania, the so-called "big bang" approach was taken. This involved dismantling TFC to make room for a small private sector which had a very limited transport, storage, and marketing capacity. On the other hand, the gradualist approach suggests that the government should withdraw slowly, since building private sector capacity will take a long time.

Similar to Tanzania, countries which have taken the "big bang" approach (such as Ghana, Zambia, Poland and Russia) have lowered fertilizer use (Bumb and Baanante 1996) during the liberalization period. On the other hand, Bangladesh took a step-by-step approach, which involved privatizing retail marketing first, followed by privatizing wholesale marketing, and then privatizing fertilizer importation. This process continued from 1980 to 1993, and at each stage, the necessary management, institutional and infrastructure capacity was developed, resulting in an annual 8 percent increase in fertilizer use during this period (Ahmed 1993).

Table 6 also indicates that most farmers are using farmyard manure as a means of maintaining soil fertility, except in Mrijo Chini. Even in Haubi, where livestock keeping is highly restricted, except for ploughing and dairy purposes, almost 55 percent of the respondents are using farmyard manure. During field investigation, some farmers indicated that farmyard manure has a long residual effect and does not have to be applied every year. They also recognize that farmyard manure could help to trap the chemical fertilizer and make it more effective. Hence, increasing the supply of farmyard manure is a viable option in the restoration of soil fertility and enhancing soil organic matter among smallholders in the study area. The existing destocking measures which forbids the keeping of livestock except for traction (discussed in Chapter 3) in the Kondoa Eroded Area, including Haubi village, puts these farmers at a great disadvantage, and it would seem prudent to re-examine this policy.

The findings of this study also suggest that agroforestry is not widely used as a means of maintaining soil fertility (Table 6). Agroforestry could play a potentially valuable role in enhancing soil organic matter and improving land productivity (Sanchez 1995; Cooper and others 1996; Nair 1992; Kidd and Pimentel 1992; and Cook and Grut 1989). Soil organic matter helps retain essential nutrients, improves infiltration and water-holding capacity, and reduces erosion (Wommer and Swift 1994). Even when inorganic fertilizer is available, a minimum amount of organic matter is required for its efficient use (Budelman and Zander 1990). Given that external inputs may continue to be unaffordable and the poor infrastructure, marketing and storage facilities of Kondoa District, agroforestry could be useful in maintaining soil fertility. But further

investigation is merited to establish agroforestry as a profitable investment and the best alternative for the sustainable increase of land productivity.

A considerable number of farmers indicated practicing agroforestry in Bereko (Table 6). More Bereko farmers (46 percent) also reported relying on agroforestry to deal with a fuelwood shortage compared to other villages (see section on fuelwood). The reason for the number of farmers practicing agroforestry in Bereko is likely to be because of the ILO-supported agroforestry project that operated there. However, the majority of farmers in all villages, including Bereko, do not practice agroforestry. This could possibly be for two reasons. First, the practice of agroforestry as proposed to farmers may not be profitable under the ecological and socio-economic circumstances, unless it is subsidized. Second, given the general weakness of the extension service in reaching Kondoa District villagers in a systematic way (discussed in Chapter 4), farmers may not be fully aware of the benefits of agroforestry or are not acquiring the technical information to effectively integrate trees with traditional crops.

The majority of farmers in the study area are also not using improved seed, except in Bereko. The reason for most farmers reporting the use of improved seed in Bereko is due to the Sasakawa Global 2000 project, which distributes improved varieties of maize, beans, and drought-resistant crops around Bereko. In fact, it was in Bereko that most farmers indicated the growing of short-maturity variety maize (74 percent) and drought-resistant crops such as potatoes (30 percent) as measures they took in times of drought. There were also a number of extension activities witnessed in this area during field work associated with this study.

Most farmers in the study area have experienced drought and some type of food shortage which they attribute to lack of rainfall. This finding supports previous studies which have emphasized that a lack of rain was the major cause of famine in the semi-arid part of Central Tanzania (Brooke 1967; Latham 1964; Mascarenhas 1966). In times of crisis, most farmers in Haubi and Mrijo Chini reported buying food, whereas in Goima they depended on food assistance from relatives or through casual labor or selling livestock. Farmers in Goima also depend more heavily on livestock for coping with food shortages, as compared to other villages. Haubi is close to Kondoa town, and some farmers are involved in off-farm income generation activities, and are thus likely to have cash to buy food in times of drought. Most farmers in Mrijo Chini are large-scale farmers who invest in farming to get a quick return and are likely to have access to cash.

Except in Goima, most farmers in the study area claimed that they have not received government or outside assistance in times of drought and food shortage. This could be either because there is no mechanism or safety net for coping with drought and associated food shortages in Goima or because food shortages have not been as acute in other villages as in Goima to necessitate government intervention.

CHAPTER 3

FARMING PRACTICES

Over 90 percent of the population in Tanzania is rural and depends on land resources for its livelihood. Hence, an examination of farming practices is critical to any study of the man/land interrelationship as well as to understand the degradative process.

The farming system in Kondoa District is agro-pastoral. However, the emphasis on cropping and livestock activities may vary from one village to another. For example, livestock is an integral aspect of the farming system in Bereko but not a major source of livelihood or income in Goima. This chapter examines the impact of cropping and livestock practices on land degradation.

Cropping Systems

A common feature of the cropping systems in Kondoa District is the widespread practice of intercropping. Intercropping, particularly that which utilizes legumes, is a deliberate measure to maintain soil fertility. For example, in Haubi, intercropping is so intensively practiced that it is difficult to identify which is the main crop. In Haubi, intercropping always involves incorporating a legume, such as beans or cowpeas, with other crops. The emphasis on legumes is to enhance soil fertility, since destocking has made farmyard manure unavailable. In addition, inorganic fertilizer use has fallen drastically because of the high prices (see Chapter 2).

Because intercropping is also an effective means of spreading risk in areas where rainfall is unreliable, the overwhelming number of farmers in the study area practice it. This study revealed that the actual combination of crops intercropped in the farming system may vary from one place to another, presumably due to variations in the local conditions. For example, in Haubi, there are three common intercropping systems, namely, maize + beans + cowpeas; maize + beans; and maize + pigeon peas +finger millet. In Goima, it is maize + finger millet; maize + sunflower; maize + sorghum. In Bereko, it is maize + cow peas; maize + beans; and millet + cow peas. In Mrijo Chini, it is maize + finger millet; and maize + sun flower. It should be noted that in Goima and Mrijo Chini, legumes are not used as much as a measure to increase soil fertility. This again supports the earlier observation that farmers in these two villages are not investing in land improvement practices.

The hand hoe is the most commonly used tool for cultivation in Kondoa District. This is generally true for Tanzania where over 70 percent of the cropped area is cultivated by the hand hoe, about 20 percent by ox-plough and 10 percent by tractor (Oxford University and Sokoine University Vol. 2, 1992). Most farmers in Bereko and Haubi use

animal traction, which is rarely used in Goima and Mrijio Chini (Table 7). Tractors are used by a large number of farmers in Mrijo Chini.

Table 7: Farm implements used for tillage practices

Implements	*Haubi (%)*	*Goima (%)*	*Bereko (%)*	*Mrijo Chini(%)*
Hand hoe	88	96	20	94
Oxen	68	24	76	18
Tractor	0	24	12	58

Source: Authors' data, 1997

Most farmers in Mrijo Chini, and some in Goima, are using hired tractors to cultivate and clear new land. Farmers in these villages, particularly in Mrijo Chini, own and operate comparatively large farms on the plain, which are suited for mechanized cultivation. In most cases, both tractors and labor are hired for the first ploughing, and are often used in an environmentally damaging way. Field observations in Mrijo Chini showed that, for the purpose of efficiency in operation, tractors were tilling up and down the slopes rather than along the contour, causing severe erosion in some areas. Other observers also noted similar practices in some areas of Goima (Östberg 1995).

The ways in which crop residues are utilized in a farming system has important implications for nutrient recycling and soil and water conservation. Generally, in Kondoa District, crop residues are used for livestock feed, domestic fuel, and/or as compost manure. Results from the study areas show great variations in the purpose and intensity of crop residue utilization. This variation is influenced by the specific physical and socio-economic forces operating in the locality.

In Bereko and Goima, the majority of respondents (64 percent and 52 percent, respectively) use crop residues for feeding livestock. In Bereko, crop residue is systematically used for livestock feed since livestock have very limited access to grazing land. Moreover, the crop residue fed to animals is used to enrich soil fertility through farmyard manure. On the other hand, in Goima, livestock are fed on crop residue as part of the grazing pattern, where they are left to roam freely on cultivated land immediately after harvest. The majority of farmers in Goima (62 percent) -- more than in any of the other villages -- burn crop residue to eradicate pests and tsetse fly and to ensure a good regeneration of grass. This indicates that they do not depend on crop residue for feed or to maintain soil fertility. Instead, they have a well-timed grazing system by which they move their cattle outside the village (often to Masai plains) during the dry season and time of burning.

In Haubi, more than anywhere else, most of the crop residues are used for making compost manure. This is the farmers' own innovative mechanism for dealing with limited farmyard manure (due to destocking) and limited use of inorganic fertilizer (due

to high prices). Most of the respondents in Mrijo Chini utilize crop residues for cooking. Large-scale clearance of forest and natural vegetation for cultivation in these areas has resulted in shortages of fuelwood. A considerable number of farmers in Bereko also use crop residue for cooking. This response may be suspect at first glance, given the plentiful forests and woodlands in the surroundings area. However, most of these woodlands are forest reserves and not accessible to villagers.

The use of fire as part of a land management tool is widely practiced by farmers in Goima (100 percent) and Mrijo Chini (54 percent), as opposed to farmers in Haubi (22 percent) and Bereko (4 percent). The reason for nearly everyone in Goima using fire is the significance of livestock and pasture to people in the village. Fire is the best means of reducing the incidence of livestock disease, such as trypanosomiasis. It also encourages the fresh regeneration of grass and pasture for livestock. Fire in Mrijo Chini is often used when clearing new land.

However, the uncontrolled use of fire, as witnessed in these areas, could destroy vegetation cover, soil organic matter, and the diversity of soil fauna. This would increase the incidence of erosion and vulnerability to various types of degradation. Frequent burning may also adversely impact afforestation efforts in the area. Thus, the environmental cost of using fire as a rangeland management scheme may outweigh its short-term benefit and will adversely impact on soil fertility as well as environmental sustainability.

Fuelwood

In the study area, fuelwood is the single most frequently used source of household energy. This study establishes that deforestation in the study area is essentially due to agricultural expansion rather than to households trying to meet fuelwood needs. The areas where farmers reported serious shortages of fuelwood closely coincided with those areas where extensive clearing of forest is taking place for cultivation. This was observed in Mrijo Chini.

Reports by farmers and the field team's observations confirmed that there is no serious shortage of fuelwood in the study area. This is supported by the fact that most respondents do not walk long distances to collect wood. One exception is Mrijo Chini where 94 percent of the respondents walk 5 to 10 km to collect wood (Table 8). The apparent fuelwood shortage in Mrijo Chini is essentially due to the large-scale clearing of forest land in the plains, often by heavy machinery and burning, for agricultural expansion. It is not related to satisfying household fuelwood requirements.

Table 8: Average distance to collect wood

Distance (km)	*Haubi (%)*	*Goima (%)*	*Bereko (%)*	*Mrijo Chini (%)*
Less than 1	52	12	2	0
1 - 5	38	78	84	40
6 -10	0	4	2	42
>10	0	0	0	12

Source: Authors' data, 1997

As shown in Table 8, it is only in Haubi (52 percent) that a significant number of farmers travel less than 1 km to collect fuelwood, suggesting that fuelwood is available close to their homes. What might be the reasons for this? First, Haubi has benefited from HADO afforestation activities which have promoted individual tree planting. Second, by virtue of being close to Kondoa town, Haubi may have gained more from the Village Afforestation Program in Tanzania which has been active in Kondoa District in the past two decades. Under the Forest Division, the Village Afforestation Program planted trees on land allocated by villages. However, seedling production to serve the whole of Kondoa District was centralized in five nurseries close to Kondoa Town. Given the Forest Division's lack of transport facilities and the relatively poor infrastructure in the district, there may have been no distribution of seedlings to many villages outside Haubi.

The Village Afforestation Program has been active in Bereko since 1985 with funding from the International Labor Organization (ILO). Yet, very few respondents in Bereko indicated walking less than 1 km to get wood. The ILO-supported effort in Bereko emphasized employment generation through hiring local people for the establishment and management of communal woodlots. With paid forest attendants, communal woodlots were well-managed, but only during the project period (Kerkhof 1990). Hence, the program may not have increased individual tree planting in Bereko. In fact, most farmers may well be collecting dead wood from forest reserves with or without the knowledge of the local authorities. It was only in Bereko that a considerable number of farmers reported that the government prohibitions against cutting indigenous trees were the main reason for the fuelwood shortage in their village.

There was a clear consensus among the interviewed farmers about which measures would best address the fuelwood shortage in their villages. Nearly all respondents agreed that planting communal trees and village woodlots would not help with the problem; instead, they preferred planting trees on individual farms. The experience with the Village Afforestation Program in Kondoa, which focused on communal woodlots, illustrates why farmers may be justified in these views. Under the village woodlot program, about 1000 ha of land were planted between 1973 and 1985. By 1989, this operation came to a standstill as villagers saw no benefit to themselves from this program, and, therefore, showed little interest in protecting and managing

woodlots. Also, there was extensive damage from grazing, burning and cutting (Kerkhof 1990). As a result, the Forest Division is now promoting tree planting on the farmer's own land.

Livestock Keeping

Overgrazing is one of the major forces fueling the land degradation problem in the semi-arid and arid areas of Tanzania, where agropastoralism is being practiced on marginal lands. The official view on land degradation in these areas is that large numbers of livestock are causing overgrazing and subsequent land degradation. Destocking was considered an appropriate measure to deal with the problem. Consequently, in 1979, over 90,000 domestic animals were compulsorily removed from nineteen villages in the Kondoa Eroded Area by HADO (Kikula 1996).

The destocking measure is in direct contradiction to the social and the cultural values attached to livestock by rural society. For various social and economic reasons, rooted in their traditions, farmers in the study area would generally like to maximize their herd size. Livestock is considered a sign of wealth and kept in large numbers in Kondoa District (Mung'ong'o 1995). Even with the apparent shortage of pasture reported in all villages during field work, the majority of interviewed farmers indicated their desire to maximize herd size. Farmers were not given any compensation for the loss suffered by destocking nor are they aware of any perceptible benefits. Suffice it to say, the destocking measures are unpopular among farmers, and their implementation difficult in Kondoa District. For example, field observations showed that destocking regulations are not generally being complied with in the Kondoa Eroded Area. This is also confirmed by another field study which witnessed peasants protesting by burning HADO tree plantations on former grazing areas, opening up farms in eroded areas without permission, and grazing illegally on destocked areas in spite of HADO policing (Mung'ong'o 1995).

Recently, HADO has attempted to reintroduce livestock through zero grazing technology in the Kondoa Eroded Area. The main objective is to address the increased incidence of malnutrition in the area caused by a shortage of milk, while generating income through the sale of milk (Shayo and Kategile 1992; Shayo and others 1993). The zero grazing approach centers on improved dairy cow and stall-feeding systems, and stipulates that participating farmers should have enough land (about one acre) for fodder. It also requires farmers to construct a cowstall and hay shed, ensure availability of water, purchase necessary dairy and veterinary items, and pay a down payment for improved dairy cattle (Kerario 1996).

Field investigations revealed that villagers have not widely adopted the zero grazing approach. Some of the main reasons for this, as identified by Kerario and confirmed by field investigations, are a high demand on labor, lack of cash to buy improved dairy cattle, lack of markets for milk, and a shortage of land for pasture

(Kerario 1995). There was also little participation among farmers in the decision-making process leading to the recommendation of the zero grazing technology. Furthermore, while the project objective is primarily milk production, farmers in the sample villages did not view milk as their major priority. In fact, the main purposes for keeping livestock are security against crop failure, a source of food and investment, draft power, farmyard manure, and social status which was also observed by Kerario in the same study area (Kerario 1995).

The economic merits of zero grazing, particularly with milk production, are still uncertain. A study in Dodoma District, Mvumi area, have projected the returns from zero-grazed cows over a ten-year period assuming an "ideal" condition. Based on this analysis, after 3.5 years, farmers could receive 31Tz shs/hr from milk production, which is higher than the official minimum wage (Holtland 1996). However, the Muvumi area is close to Dodoma town, and has a good market nearby where selling milk could be profitable. On the other hand, experience from the West Usambaras area of Tanzania showed that the system was labor-intensive, stall construction and improved cattle were unaffordable for many farmers, improvements in milk yields were comparatively low, and the system could not cover its costs (Kerkhof 1990). In addition, a few of the farmers who have adopted zero grazing in Haubi reported their main reasons to be milk for domestic purposes and sale, source of farmyard manure for their own fields and for sale. Sale of farmyard manure was not anticipated as one of the zero grazing objectives. But given that agroforestry is not widely practiced among most farmers in the study area (Table 6), farmyard manure could be an efficient and viable means of enhancing soil organic matter in this area.

All the sample villages are experiencing a shortage of pasture and livestock feed in varying degrees. For example, the largest number of respondents facing pasture shortage came from Goima (64 percent), followed by Bereko (48 percent). Field observations and discussions with livestock officers revealed a very high concentration of livestock in Goima, followed by Bereko. Most farmers in Goima are agro-pastoralists who attach more significance to livestock-keeping than cropping.

Rainfall failure affects the availability of livestock pasture in the same way as it affects food availability (Chapter 2). Farmers, depending on their locality, have devised their own measures to mitigate pasture and livestock feed shortages. These measures included grazing in distant places (as practiced in Goima); storage of crop residues (as practiced in Bereko and Haubi); and grazing in river valleys (as practiced in Bereko).

Water for livestock and domestic purposes is a key issues for among all the sample villages. The overwhelming number of respondents have no permanent source of water for livestock, except at Mrijo Chini, where a few farmers had access to pumped water from boreholes. Large swamps on the Masai plains are a source of water and watering points for livestock in Goima. In Haubi, a major source of watering points is shallow wells on sand rivers and sand fans. Small streams in Bereko are common watering points.

Trampling along livestock routes and around the watering points have caused severe rill and gully erosion in the study area. This type of degradation was also reported in other studies (Murray-Rust 1972; Strömquist and Johansson 1978; and Christiansson 1981). The core investigating team witnessed an example of this kind of land degradation on the road between Goima and Chandama villages.

CHAPTER 4

LAND AND INSTITUTIONAL ISSUES

Land Availability

Land availability often influences farming practice, and affects the land degradation process. In Tanzania, as in most parts of Africa, when population density has been low and land abundant, shifting cultivation and transhumant pastoralism have functioned in ecological equilibrium. This equilibrium was possible because people moved to new areas when soil fertility declined or pasture was exhausted. This mobility allowed the land to recover. As population density increased, agriculture gradually became permanent, and included such features as the integration of livestock into the farming system and the practice of various conservation measures (Ruthenberg 1980).

Many SSA countries are trying to cope with the transition from an extensive to a more intensive farming practice, and the transition is affecting soil productivity and yield. Unlike Asia, the reduction in fallow periods in SSA has not corresponded with other soil-enriching practices, particularly with the use of inorganic fertilizers. In fact, fertilizer use has declined substantially in the study area due to the prohibitive price of fertilizer (see Chapter 2). As a result, most farmers rely on intercropping, ploughing crop residue, utilizing farmyard manure, composting, and planting of nitrogen-fixing crops (Chapter 3).

Tanzania is well endowed with natural resources and has a diverse ecosystem to support a viable economy based on agriculture, livestock, and tourism. Approximately 45 million ha of the land is under forest cover (which is half of the total mainland area), of which 22 million ha (the largest in SAA) are under reserve. With a population of over 25 million, Tanzania has a low population density of 26 persons per sq km. Land with good agricultural potential is estimated at 10 million ha, of which about half is cropped annually (World Bank 1994). Hence, in the short-term, land which can be brought into cultivation, particularly among smallholders is relatively abundant. The only exception is the fertile and densely populated area in the north, where population density in some regions (such as Kilimanjaro), can exceed 200 persons per sq km.

A major constraint to land use is that over 50 percent of the country is infested by the tsetse fly. Livestock are then concentrated in tsetse-free areas, which causes overgrazing and conflicts with agricultural land users (De Pauw 1995). The availability of good agricultural land at its current level differs substantially by region. The southwest contains a substantial underutilized area, while four regions (Dodoma, Kilimanjaro, Dar-Es-salaam, and Singida) are overusing the available high-potential land (World Bank 1994). In spite of the basic difference in the farming systems of the four regions, (such as the intercropping of coffee-banana in Kilimanjaro and agro-pastoral

production in Dodoma), the enormous pressure placed on suitable land is causing agricultural expansion in marginal areas.

The size of landholding in the study area varies considerably. Ninety percent of the farmers in Bereko, and 76 percent in Haubi own less than 10 acres of land. The figures for Goima and Mrijo Chini are considerably less: 40 percent and 36 percent respectively. However, 40 percent of the farmers in Mrijo Chini and 22 percent in Goima own more than 20 acres, while this figure was 6 percent for Haubi and 4 percent for Bereko. There is intense pressure to use the land to its maximum potential in Haubi and Bereko, and nearly all the farmers cultivate all their land, with little room for expansion, except in marginal areas. Chapter 2 discusses farmers' response in these two villages to the ensuing soil fertility decline through intensification. This is quite unlike farmers in Goima and Mrijo Chini who often abandon degraded and less productive land and clear new land for cultivation. In fact, a considerable number of farmers in Mrijo Chini have farms large enough (some over 40 acres) to warrant the use of tractors to do the clearing and cultivating.

Land fragmentation is closely linked to land availability, population pressure and productivity. The literature on land fragmentation generally stresses that it discourages soil conservation, makes an "impractical" use of modern inputs such as chemical fertilizer, and reduces the profitability of agricultural investment and the use of technological innovation (McPherson 1982). Others point out that land fragmentation "spreads risk" which is associated with micro-climatic variations, pests, and diseases (Collinson 1983).

During the field survey, the adverse and beneficial aspects of land fragmentation were observed in Haubi and Mirijo Chini. The majority of farmers in Haubi (90 percent) and Mirijo Chini (66 percent), had more than one plot. But what seems to be important in influencing the negative effect of land fragmentation is the number and size of the parcels per holding, and the distance one travels from the homestead. Fragmented land holdings of more than two parcels is particularly widespread in Haubi. A different field study confirmed that the average household in Haubi owns four plots (Mohamed 1995).

The advantage to having plots in hilly areas as well as in the more fertile alluvial deposits of the valley bottom was observed in Haubi where farmers fully exploited their ecological niches by planting food and cash crops, leaving certain areas for grazing. However, the high population density in Haubi, particularly the high ratio of children to adults, (Table 9), could cause further redistribution of land and substantially reduce the size of fertile plots. This would make any meaningful investment in land or technological innovation impractical.

There was no consistent relationship between land fragmentation and the distance that farmers traveled from their homesteads to their most fertile plots. In Haubi, where most farmers have several parcels of land, approximately half the respondents reported walking less than 1 km to their most fertile plot. Similarly, in Bereko, where the majority

of farmers indicated their land is in one unit, they also walk less 1 km to their most fertile plot.

However, field investigations suggest a close correlation between distance traveled to the most fertile plot and good farming and land management practices. Most of the fields (shambas) in Bereko and Haubi were well-maintained and had at least some kind of soil conservation measure in place. Less walking distance has contributed to transporting manure and other residues easily to the farm and encouraging more intensive farming, since the option for expansion is limited. On the other hand, a large number of farmers in Mrijo Chini travel more than 10 km to operate large farms, which displayed few good management practices. These farmers practice extensive farming which is dependent upon the clearance of more land for cultivation. This is often done in an environmentally unsustainable manner.

Farmers' responses about changes in the size of their cultivated land in the last few years, and the distance they travel from their homestead to clear new land, provide insights about land degradation and land availability inside and outside the village. Except in Mrijo Chini, where a considerable number of respondents reported a decrease in their land size, most indicated no significant change within the study area. In Haubi, some of the farmers who reported an increase in their land size were actually traveling well over 10 km to clear new land, suggesting an expansion to the lower Irangi areas in the Kondoa lowlands as has been done traditionally by well-to-do farmers of Haubi (Mungo'ngo 1995).

In Bereko, there was very little response about change in farm size or expansion to clear new land, suggesting no room for expansion inside and outside the village. Yet, only Bereko had no negative response regarding land being lost to the degradation process. Farmers in Bereko exercise good conservation practices to control the land degradation because investment in soil conservation practices are economically attractive to farmers as a result of the increased "scarcity value" of land and lack of access to new land. A similar response among farmers was observed in areas of serious land shortages, such as Ukara in Ukerewe District (Ludwig 1968) and the Chagga in Kilimanjaro (Young 1989). The opposite is happening in Goima and Mrijo Chini where it is more profitable for farmers to clear new land, rather than making improvements to cultivated land.

A large number of farmers in Goima and Mrijo Chini reported a decrease in cultivated areas because of erosion and gullies. At the same time, many of these farmers reported clearing new land inside and outside their villages for cultivation. This was done partly to compensate for the land lost in the degradative process. But extensification could also be used as a strategy for land expansion since one could claim, even after leaving the area, ownership of land that one has cleared previously. For example, some farmers in Mrijo Chini are leasing the land they have cleared and abandoned to expand into a different area.

About 44 percent of farmers in Goima were traveling up to 5 km from their homestead to clear new land for cultivation while this number was 8 percent in Mrijo Chini. This probably means that the village area in Goima is expanding and that land is available within a short distance from the village. In Mrijo Chini, a large number of farmers were traveling over 6-20 km. This reflects expansion outside the village area. Field observation also confirmed that compared to other villages, farmers in Mrijo Chini walk a considerably longer distance from their homestead to cultivate their fields and clear new land.

A key consideration regarding land availability is how long new land will be available for agricultural expansion. In addressing this issue, the cost to conserve and maintain the productivity of already cultivated land, as opposed to the cost of clearing new land, will be important. The expense involved in this example should be seen in a broader context to include labor and capital. As seen in Chapter 2, most physical conservation schemes are costly, averaging well over 100 days for establishment and maintenance. Since the elimination of subsidies, the cost to use a bag of fertilizer (per hectare) is far greater than the monetary wages of unskilled laborers. On the other hand, from farmers' responses, it would take twenty-five to thirty days to clear 1 ha of land using hand hoes, and about ten to twenty days using machinery. Hence, in areas where land is freely available, it seems rational to keep clearing new land for cultivation rather than making an investment in conserving and maintaining the productivity of old land.

The study also revealed very few land transactions - except for a handful of farmers (about 10 percent) in Haubi who had sold their land, and this was the reason for a reduction in their farm sizes. This is similar to findings which showed that nationally, only 7 percent of rural households purchased land in the last decade (World Bank 1993). This suggests that the scarcity value for land is generally low and will stay low, as long as land is freely available. This was observed in Goima and Mrijo Chini, where farmers count on expanding into new areas, rather than taking conservation measures which they feel are demanding or costly.

Farmers in Mrijo Chini were not interested in using fertilizer or other soil conservation measures, but counted on clearing new land when the soil was exhausted. This option, however, is not available in agriculturally high-potential areas like Bereko where the population density is high. Until freely available land is no longer feasible and land has some kind of scarcity value, farmers in Goima and Mrijo Chini as well as other parts of Tanzania, will prefer to keep on clearing new land, rather than making improvements in existing land, particularly if it is degraded.

The study also revealed that children constitute more than half of the village populations. Such low producer/consumer ratio places a considerable burden on producers (Table 9). The large number of children, as compared to adults, indicates that there will be growing demand for land, and that, in the future, land shortages may become much more severe. Even in the land-abundant areas around Mrijo Chini, labor-augmenting technologies, which are environmentally sound, will be essential for

increasing the yield per unit area. In areas where there is acute land scarcity, such as Haubi and Bereko, a high child-to-adult ratio could result in more land fragmentation.

Table 9: Average number of people in the household and producer/consumer ratios for the four sample villages.

Village	*Children*	*Adults*	*Old/ Disabled*	*Total*	*Producer/ Consumer ratio*
Haubi	4.46	2.12	0.32	6.90	0.31
Goima	3.84	1.90	0.64	6.38	0.30
Bereko	3.92	2.74	0.14	6.80	0.40
Mrijo Chini	4.70	2.76	0.38	7.84	0.35

Source: Authors' data, 1997

Land Tenure

Customary land tenure system is widespread in Africa. Declining agricultural productivity in SSA has raised the question of whether there may be a significant relationship between declining productivity and a customary or indigenous land tenure system. At the center of the debate is the assumption that a customary land tenure system does not provide adequate security, but is instead an impediment to subsistence farmers who would like to make investments to improve land and agricultural output (Dorner 1972; Harrison 1987). In past decades, several studies have challenged this assumption, pointing out the complexity of a customary land tenure system and that the system is compatible with intensive agriculture (Cohen 1980; Feder and Noronha 1987; Bruce 1988; Binswanger and McIntire 1987; Migot-Adholla and others 1991).

Customary land tenure system is also closely associated with shifting cultivation which provides tenure until one moves to a different piece of land. Since most rural lands in Tanzania are under a customary land tenure system, and shifting cultivation is still practiced by most farmers, the farmers interviewed for this study were asked whether they felt secure about the land they cultivate, and if their sense of security, or lack thereof, has influenced them towards making investments in their land.

The findings indicate that most of the sampled farmers in the four villages (Haubi 98 percent ; Bereko, 96 percent; Mrijo Chini, 82 percent and Goima, 72 percent) feel secure about the land they cultivate. This is not surprising since after a century of colonial and post-colonial rule in Tanzania, little has changed in the legal basis of land tenure (De Pauw 1995). The land tenure laws in Tanzania are based on the Land Ordinance of 1923 enacted by the then British government. The Land Ordinance has three fundamental elements which are still retained in the existing land tenure system. They are: (a) all land in Tanzania is public land; (b) the power of control and administration is vested in the President on behalf of all citizens; and (c) the right of

occupancy, whether granted or deemed, is the primary mode of access to and use of land in Tanzania. In addition, the Land Act of 1995 states that land belongs to the citizens, the President is the trustee and people have the legal right to own land.

The overwhelming majority of subsistence farmers hold land under the "deemed" right of occupancy and operate within a customary tenure system. These lands are allocated by local authorities, not subject to development regulations, and can be held in perpetuity by smallholders. The Land Act of 1995 further strengthened the rights of smallholders under customary land tenure by stating the three principles mentioned above. Hence, the farmers feel secure about their land tenure because the regulations governing customary land tenure are clear and ensure their right of ownership.

A closer examination of the minority of farmers in Goima (28 percent) and Mrijo Chini (14 percent) who do not feel secure about their tenure shows that this insecurity had little to do with the customary land tenure system. Rather, it was due to the influx of land-grabbing new settlers and the manner in which they secured their land in the village. In old settlement areas such as Haubi and Bereko, access to land is through inheritance. In contrast, many villagers in Goima (except the native Buriunjis) are new settlers who have often seized land without the knowledge of village and local authorities. In fact, most of those who feel insecure about their land in Goima, viewed the land as the property of the government.

Most of the people in Mrijo Chini are also new settlers with no tradition of owning land in the area. But, unlike in Goima, many villagers in Mrijo Chini are large-scale farmers who invest in farming for a quick return and then move on to clear new land, often with the assistance of hired tractors. Some of these farmers may have actually purchased land and possess some type of transaction document (as witnessed for one farmer during field work). They may also have received approval from the local authorities, slightly increasing their sense of security. This contrasts with the situation in Goima.

Most of the sampled farmers in every village, except Mrijo Chini, feel that investing in land is profitable, and have already made this investment. The most notable and diverse investments by farmers were made in Haubi and Bereko. Very few, however, were made in Goima and Mrijo Chini. In Haubi, 36 percent of respondents invested in the construction of contour bunds followed by 32 percent in the preparation and distribution of composite manure, 20 percent in tree planting, and 18 percent in inorganic fertilizer. In Bereko, 80 percent of the respondents have in the past made investments in their land by buying inorganic fertilizer, 40 percent in constructing water ways, and 30 percent in tree planting. This finding is related to the overwhelming number of farmers in Haubi and Bereko who had earlier indicated taking measures (such as terracing and strip-cropping along contours) to control soil erosion.

These findings suggest that customary land tenure has not been an impediment to investing in land. A similar observation is made by another study in Tanzania where

smallholders make investments in land through the purchase and application of inputs and other soil conservation measures (Oxford University and Sokoine University Vol. 1, 1992). Hence, this study gives additional weight to the Bruce and Migot-Adholla empirical case studies that found indigenous African tenure (which may not officially guarantee continuous rights) has not made farmers insecure or discouraged them from investing in land, which in turn impacts on productivity (Bruce and Migot-Adholla 1995). Similarly, comparative household data in Ghana, Kenya, and Rwanda found that indigenous land right systems are not a significant factor in determining investment in land improvements, use of inputs or productivity of land (Place and Hazell 1993).

Most farmers in Mrijo Chini (52 percent) chose not to express their views on the profitability of investing in land. This is not because they consider land to be unprofitable, since most of them have come seeking a quick return from farming. Instead, they see no need to invest in or improve the land when they can expand or freely move elsewhere when conditions become unsuitable for production.

It is noteworthy that 40 percent of the respondents in Bereko – more than anywhere else – are constructing water ways and diversion channels to drain the water along the contour and prevent excessive run-off during the rainy season. This is labor-intensive work. Bereko is a hilly area with considerable slopes, and designing water drainage systems along the hill is difficult. Yet, farmers in Bereko are making this physically demanding investment, because their village is densely-populated and surrounded by forest reserves, and they have limited options for expansion.

The problem in Tanzania centers on land conflict between agriculturists and pastoralists over grazing rights and the destruction of crops by livestock. The recent introduction of National Land Policy (MLHUD 1995) is largely to resolve land use conflicts which have been increasing. The major causes for this conflict are the expanding rural population, which has doubled in the last twenty-five years, and an increase in the livestock population. The expansion of agricultural land is estimated at 2.5 percent per annum which is also the estimated rural population growth rate (World Bank 1994). Overall, land for agriculture is abundant in Tanzania, but over 50 percent of the land is infested by tsetse, resulting in a concentration of livestock in tsetse-free areas. This has led to increased conflict with agricultural users over grazing rights. The expansion of agricultural land often threatens traditional pastoral areas rather than land for forest and wildlife, which are protected reserves. Hence, the major land conflict occurs between crop production and pastoral or agro-pastoral production systems.

The findings from the village on the issue of land conflict seems to support this phenomenon as well as its occurrence in other parts of the country. This type of conflict (regarding the ownership of land and grazing rights) was frequently cited in Goima and Mrijo Chini, and relatively less in Bereko and Haubi. Such disputes are particularly intense in Mrijo Chini, since these areas are traditionally used by Masai pastoralists, and are now increasingly being cleared for large-scale agricultural expansion. This has led to open conflict, and local authorities have told farmers not to expand operations into

pastoralist areas. A large number of farmers in Goima have also indicated experiencing conflict over grazing rights. This may be because many farmers have moved their cattle into the area from Haubi as a result of destocking. This may also be due to the large number of agro-pastoralists living in the area who may be in conflict with those who mainly cultivate crops.

Local Organization and Extension

Strengthening land users associations at the grassroots level is likely to play a critical role in dealing with land degradation. Local organizations, with appropriate support and encouragement, could facilitate participatory development and help address land degradation (Thrupp 1996; Scherr and Yadav 1996; World Bank 1996; Ghai and Vivian 1992). Local people may then see themselves as stakeholders in the management of land resources. But in many countries, partly due to the colonial experience and a top-down policy and management approach, local organizations have not taken root in many rural areas. Even where such organizations exist, they are often seen as a tool for implementing government policies. As a result, local participation has been marginal. This has often been the case in Tanzania.

In the survey, specific questions were posed about whether farmers belong to any type of local association, and, if so, whether they participate within the village. The responses revealed that very few farmers knew and were actually affiliated with some type of local association. Only a minority of respondents in Haubi (20 percent) indicated having some type of affiliation with a local association, particularly with the recently initiated Cooperative of Zero Grazers. The absence of local organizations which focus on conservation and land resource management is surprising given that various donors have supported conservation projects for decades in Haubi and the surrounding areas. Farmers' reluctance to participate in local associations is likely due to their negative experiences with government-initiated conservation measures (such as destocking) and the belief that such an association could be used as a rubber stamp to promote unpopular conservation measures.

During field work it became clear that none of the tribal, civic, and religious leaders were consulted before taking the drastic measure of removing livestock from the Kondoa Eroded Areas (Chapter 3). This illustrates the absence of dialogue between officials and villagers about decisions which so profoundly affect the livelihood of local communities. Needless to say, officials should not be surprised at the depth of resistance they encounter in enforcing conservation measures, especially when local leaders are not even aware of them.

Sustainable use of land resources requires the organizational capacity to ensure villagers participation in the decision-making of their communities. However, in many parts of SSA, government, as well as donor support may be essential in order to initiate and strengthen local organizations. At the same time, it should be clearly established that

local organizations belong to and serve the local clients. A good example is the need to initiate a fertilizer users association among farmers which would enable them to manage demand and negotiate price with suppliers.

The extension service can play an important role in facilitating and encouraging local organizations. This means reorienting the extension service so that its approach emphasizes local participation in the management of land resources and in its intervention strategies.

For this to happen, the farmers' view of the extension service and agent is central. To obtain insights into the organizational constraints, the sampled farmers were asked about the number of visits made by extension agents to their farms, and whether the advice they received from extension agents was helpful. Most of the respondents indicated seeing extension agents once or twice a year, which implies infrequent and irregular visits at the village level. What could the reasons be?

Agricultural services in Tanzania (which includes livestock) have been affected by numerous reorganizations (approximately thirteen) since independence. During this period, extension agents have switched from one approach to another without effectively reaching the village level. The number of extension agents is reported to be a little more than 9, 000. With an almost equal number of villages in the country, one out of two villages should have a resident village extension worker. But in reality, an extension agent covers three to five villages. The extension service faces serious constraints, such as lack of trained staff funding and transport, weak organizational structure, and inadequate supervision to reach farmers effectively at the village level (World Bank 1994).

Except in Goima, most of the respondents, 82 percent in Mrijo Chini, 74 percent in Bereko, and 60 percent in Haubi felt that the advice they received from extension agents was helpful. The very favorable view of extension agents in Mrijo Chini is surprising since extension and conservation activities are limited in this area as compared to the other villages. It is also striking that 57 percent of the respondents in Goima and 40 percent in Haubi had a negative view of extension agents. The agricultural extension service is generally perceived as an arm of the government, enforcing conservation measures and regulations on the rural population. This perception stems from the colonial experience and the unpopular villagization program.

Farmers in Goima and Haubi have had their own experiences which have made them suspicious of extension agents. Some agents have enforced unpopular measures, such as destocking and labor-intensive conservation work to control erosion. Instead of adopting these measures, many farmers have either moved to Goima or to the surrounding villages. Needless to say, the negative perception of extension agents and their advice among most farmers in Goima is understandable. This is because many of the farmers may have originated from Haubi. This phenomenon has been explained in detail in Chapter 2 and Chapter 3. In fact, during field work, the core investigating team

witnessed some farmers openly expressing their negative views of extension service in the presence of extension agents.

There is also a gap between extension agents and farmers similar to that exhibited by officials and local land users. The official view of land degradation in Kondoa is often attributed to overstocking and bad herding and farming practices. This is only part of the truth. Field observation has found environmentally sound indigenous knowledge and land management practices. Extension agents should build on good existing local practices and try to incorporate them into the technical package which they disseminate to farmers. For example, an observer in Goima has found that extension agents have rejected the indigenous way of constructing ridges of "fishbone pattern" when, in fact, it can capture moisture better during the dry season than the construction of a long ridge across the slope, which indigenous people believe moves too much soil around, making it vulnerable to erosion (Östberg, 1995).

Extension services must create mechanisms that build and incorporate indigenous knowledge and land management practices into the recommended technical packages in each locality. Properly-oriented extension services can promote farmers' participation, strengthen local organizations, and be proactive in responding to farmers' needs. The extension service can also help bridge the perception gap between officials and land users on the land degradation problem (discussed in previous chapters), which is central to the success of land conservation and improvement measures.

CHAPTER 5

CONCLUSIONS AND POLICY IMPLICATION

Official and local land users often have different perceptions and responses to the land degradation problem. This continues to be a serious impediment to the successful implementation of policies and projects to address land degradation at the village level. Some key examples of the perception and response gap between officials and villagers are summarized in Table 10.

Table 10: Perception and response gap to major land degradation problems

Problem	*Government Solutions*	*Results*	*Villagers' Responses*
Overgrazing	• Livestock removal • Zero-Grazing Initiative (improved dairy cows and stall feeding)	• Malnutrition • Lack of farmyard manure • Regeneration of hilly areas • Too expensive • Limited market for milk • High demand on women's time	• Livestock removed to other areas • Non-compliance with destocking regulations • Resentment of local extension agents • Limited adoption • More interested in farmyard manure than milk production
Soil Erosion	• Labor-intensive conservation (e.g. terracing)	• Recommendations not followed	• Contour ploughing • Putting crop residue and grass along contour
Soil Fertility Decline	• No coordinated strategy • Removal of subsidy	• Decreased demand for fertilizer use • Agricultural expansion on forest land and marginal areas	• Intercropping, composting, farmyard manure • Ploughing crop residue • Agroforestry • Extensification and clearing of new land
Deforesta-tion	• No coordinated national policy • Village woodlots	• Shortage of fuelwood • Encroachment and conflict on pastoral and communal lands	• Individual tree planting • Use of fire and environmentally damaging practices to clear new land

Source: Authors', 1997

As highlighted in Table 10, the conflict between the major stakeholders (officials and villagers) in addressing land degradation problem centers around the lack of villager

participation both in the diagnosis of the problem and the solution proposed. The conservation measures which enforced the removal of livestock from eroded areas and introduced labor intensive conservation measures by the Dodoma Region Soil Conservation Project (HADO) is a classic example of this gap between officials and villagers. These measures caused resentment among villagers, and contributed to the negative perception of the extension agent in the project area.

Local land users are the most critical stakeholders in any successful attempt to arrest land degradation. They would like to maximize their herd size for their own social, cultural, and economic reasons. Livestock is seen as a sign of wealth, and an asset in times of difficulty. This perception tends to encourage overgrazing and land degradation. Officials and extension agents have attempted to solve this problem by enforcing policies that reduce herd size in highly degraded areas. This action, however, has been unpopular among farmers and difficult to implement. Field investigation validated that, in cases where livestock was removed compulsorily, such as in Haubi village, animals were moved into another area, such as Goima village, where such measures are not being enforced. The net result has been transferring the problem into the surrounding areas.

The destocking policy has had the unintended outcome of increasing the incidence of malnutrition in the affected areas. An alternative approach, known as zero grazing, focused on improved dairy cows and a stall-feeding system. The primary objective of this approach is to improve nutritional status by providing milk, and increasing income through the sale of milk. However, this alternative has not been well received. Some of the major reasons cited by farmers is labor intensity, shortage of land, and a limited market for milk. Particularly, it has created more hardship for women whose responsibilities include the collection of fodder through a cut-and-carry system away from the village, and cleaning newly-constructed stables for stall feeding.

The most significant reason why villagers have not widely adopted the zero grazing approach stems from farmers views that it does not take into account the multiple roles and value of livestock in the farming system. Indeed, one of the unanticipated outcomes of the zero-grazing approach (as revealed through field validation) is that farmyard manure has become a source of cash income due to its high demand in areas where destocking has been enforced. Thus, it would be crucial to take into consideration land users' perspectives and values, local variations in ecology and socio-cultural conditions, indigenous knowledge and land management practices, in addressing the perception and response gap between villagers and officials (Table 10) as well as finding solutions to land degradation problems.

Farmers are aware that soil degradation, in various forms, is taking place on their farms as well as in surrounding areas. This awareness is largely based on their perceptions and interpretation of indicators regarding conditions on their crop and pasture land. The major physical and biological soil degradation indicators farmers cited include rill and gully erosion, water absorption capacity (level of run-off), crop yield, change in

color of crop leaves, stunted crops, emergence of weeds and unpalatable species, appearance of termite mounds, disappearance of grass, and numerous site-specific plant species which are identified in this study. Most plant species indicators are local and site-specific.

There is a wealth of indigenous knowledge which can be tapped in developing plant species indicators closely linked to soil erosion, decline in soil fertility, or degradation of pasture land. Future studies should focus on identifying the key local informants, particularly the elderly, and correlate the occurrence of a particular plant indicator species with the soil condition of that area.

Farmers' efforts to mitigate land degradation have generally focused on two major approaches. The first one involves intensification of the farming system using sustainable production systems and aims to increase productivity for the same unit of land, while the second involves extensification of agriculture into new areas. In both cases, farmers' decisions are based on their experience, what they viewed as the most serious problem affecting their livelihood, particularly the costs and benefits involved in terms of yield, labor or land expansion, as well as their interpretation of changes observed regarding land quality.

Intensification of the farming system is largely dependent on the farmer's initiative and more readily takes place where population density and labor-to-land ratios are high, where fallow periods are drastically reduced or terminated, and where the impact of land degradation affects both cropland and pastureland. This is taking place in the densely-populated areas, where farmers are taking erosion control measures such as terracing, strip cropping, bunding, building check dams, constructing water ways, and tree planting. They are also using low-input techniques, such as intercropping involving legumes, composting, use of farmyard manure, and agro-forestry to maintain soil fertility.

In some of the densely-populated areas, fragmented landholdings can adversely affect the effort to intensify farming practices. In areas, such as Haubi, where the average household has more than four plots, and where the children-to-adult ratio is high, indicating the growing demand for land, redistribution could reduce the size of farming plots to a point where innovation and intensification will be unprofitable. Understanding the adverse and beneficial aspects of land fragmentation on the degradative process and yield is relevant. This would require a more detailed future investigation on the number of parcels per holding, their size, their level of fertility, and their distance from the homestead.

Farmers' initiatives can be enhanced if they are complemented by enabling policies and suitable institutional arrangements. The proper use of chemical fertilizer could play an important role in the intensification of the smallholder production system. However, macro-economic policy, in particular pricing policy, which phased out fertilizer subsidies to smallholders, has raised the price of fertilizer compared to the output price for maize, and thus effectively reduced the demand for fertilizer. As a result, the

overwhelming majority of farmers who have used fertilizer in the past cannot now afford to use it. Increasing price has also reduced the profitability of retailing fertilizer and has negatively impacted its availability in local markets.

The decreasing demand among smallholders and the unprofitability of the use of chemical fertilizer can be addressed by a two-pronged approach. The first and the one with the most immediate outcome involves policies that provide direct or indirect price support to encourage the use of fertilizer in the densely-populated areas where farmers are aware of the benefits of fertilizer, and would like to use it in intensifying their farming practice. The second one involves a long-term objective and would involve building the private sector's managerial, institutional, and infrastructure capacity for effective participation in the importation, marketing and distribution of fertilizer at the national and local levels. Most important, government policy should focus on an integrated soil fertility management strategy that creates conditions for enhancing the supply of nutrients from inorganic, organic, and biological sources at the local level. Such a strategy could play a key role in the recapitalization of soil fertility and enhancing the productivity of the smallholder farming system.

Lack of a coordinated policy encourages extensification in environmental damaging way (such as using heavy machinery and fire in clearing new land), and often results in heavy deforestation and soil erosion. In sparsely-populated areas, where land is freely available and labor is a major constraint, farmers will opt for extensification and will bring more land under cultivation. It is also used as a strategy to get access to more land since, as mentioned earlier, one could claim ownership on land cleared previously even if one no longer resides in the area. In fact, extensification is a major driving force in deforestation within the study area. In some cases, it has also meant expanding into marginal areas, and walking a substantial distance (over 15 km) from the homestead. At the present level of farming technology and with poor land management practices, extensification is likely to exacerbate the land degradation process and affect long-term sustainability. Still, it is likely to continue until the value of cultivated land increases sufficiently due to scarcity, and farmers find it more profitable to invest in land conservation practices rather than clearing new land, or until policies which discourage extensification are put into effect.

The nexus of poverty, declining soil productivity, and food insecurity becomes evident in some of the study areas, suggesting the crucial significance of policies which target the rural poor. Poverty can be a disincentive to undertaking soil conservation and fertility-enhancing measures. Relatively poor farmers often cultivate marginal lands or combine day labor with cultivating their own farm. Their actions are directed towards maximizing immediate gains, which results in the overexploitation of the land or in not spending as much time (particularly in the planting season) to maintain it. This leads to a downward spiral that reinforces poverty, low productivity, and land degradation. Further studies should examine the relationship between farmers below the poverty line and their willingness to undertake intensification.

Animal traction could play an important role in increasing productivity, and bringing new land under cultivation in a sustainable way. Yet, nationally, as well as in the study area, the use of oxen ploughs is insignificant. This practice is mostly concentrated in the densely-populated areas where intensification is occurring, and trypanosomiasis is rare. Even in areas where livestock is plentiful and land relatively abundant, oxen were not used by most farmers. Hence, it would be valuable to investigate further the enabling mechanisms that would encourage the use of draft power in these areas and for smallholder farming systems, since they could increase returns to labor and yield per unit area in an environmentally sustainable way.

A shortage of water for agriculture and livestock is probably the most formidable development challenge facing smallholders. The lack of rain is a major cause surface water and pasture shortage in the study area. There are few permanent watering points, and the overwhelming majority of farmers use shallow wells, swamps, streams, and sandy rivers. This has caused severe land degradation around these points and along the routes leading to them. Policies to provide appropriate financial and material support in establishing more permanent watering points, as well as developing low-cost local water harvesting and moisture conservation techniques, are critical to arrest degradation and enhance soil productivity.

The examination of farming practices revealed important aspects of farmer behavior that influence conservation and the land degradation process. Deforestation was primarily a result of increasing the areas under cultivation, not fuelwood gathering. The use of fire is widespread as it is the best means of reducing the incidence of livestock disease, encourages regeneration of grass and pasture for livestock, and is also used in clearing new land. But it has the negative effects of the destruction of vegetation cover, soil organic matter, and the diversity of soil fauna, and increased erosion. There is a widespread use and increasing demand for farmyard manure even in areas where livestock-keeping is restricted. Farmyard manure has a long residual effect and enabling policies to increase its supply among smallholders is a viable option in the restoration of soil fertility. The government's efforts to initiate communal tree planting were not widely accepted, and farmers indicated their preference for individual tree planting on their farms. The practice of agroforestry is also very limited. Given agroforestry's potential to serve a multiple role by providing cash, fodder, fuelwood, and by enhancing soil organic matter, future studies should examine and demonstrate whether the agroforestry system would be profitable to farmers.

Some of the key institutional factors influencing farmers' behavior in undertaking land improvement measures are land tenure and the capacity of local organization and extension services. Farmers in general feel secure about the land they cultivate under the customary land tenure system and do not regard the land as belonging to the government. Customary land tenure authority is vested in local leaders, not subject to regulation, and can be held in perpetuity by farmers. Consequently, this has not been an impediment to investing in land. Indeed, most farmers have invested in or improved their land in terms of tree planting, buying fertilizer, using farmyard manure, constructing terraces and water

ways, etc. Lack of investment in certain areas stemmed more from poverty than from an unwillingness to invest because of insecurity of tenure.

A more pertinent land issue seems to be conflict over grazing rights involving predominantly crop producers and pastoralists. This conflict is more acute where large-scale operators are expanding into traditional pastoral and grazing areas, as observed in Mrijo Chini. In areas where there is a large tract of common property resources, the current laissez-faire approach is accelerating conflict and the degradative process. Government policies must protect communal and pastoral land rights against the onslaught of excessive land grabbing by large-scale operators.

Farmers are reluctant to participate in local associations mainly due to their negative experiences with government-initiated, top-down conservation efforts and the belief that such an association could be used as a rubber stamp to promote unpopular measures. An example is the compulsory removal of livestock and introduction of labor-intensive conservation measures in the HADO project area. Furthermore, the extension service does not systematically reach the village level, there are few extension agents at the village level and visits from the extension service are infrequent. Farmers are suspicious of extension agents as they often see their objectives as being the conversion of communal lands into government managed protected or conservation areas, which they will not be able to use.

The extension service does not reach the village level systematically and farmers are suspicious of the motives of extension agents, particularly in areas where unpopular conservation measures are enforced. However, the extension service could play a vital role in bringing scientific and indigenous technical knowledge closer as well as in achieving convergence between official and local land users' approaches and responses to land degradation. Indigenous technical knowledge is built upon the lifetime experience of farmers. It may not, however, keep pace with new changes and problems. The extension service could enhance farmers' awareness about these changes and guide them regarding the appropriate response to new, unfamiliar situations.

The crucial challenges facing extension services are (a) developing a technical package in improved crop and livestock practices tailored and fine-tuned to a specific farming system and agro-ecological condition; (b) incorporating tested indigenous knowledge and land management practices into the technical packages; (c) increasing nutrient uptake efficiency by developing the best combination of organic and inorganic fertilization methods; (d) involving civic society and the appropriate local organization before launching conservation measures; (e) working closely with research institutions in developing and introducing early maturing and drought-resistance crops.

This study has underscored the fact that the intensification process is under way and is undertaken mostly on the farmer's own initiative. There is also a process of extensification occurring, by both small and large-scale farmers, in an unsustainable manner. Enabling policies and institutional arrangements can create favorable conditions

to encourage intensification through such means as increasing the use of inorganic fertilizer as well as organic fertilizer (such as manuring, composting, minimum tillage, ploughing crop residue etc.) provision of permanent watering points, development of low-cost water harvesting techniques, expanding draft power, and strengthening local organization and extension services. At the same time, there is also a need for policies that discourage environmentally damaging land-use practices, such as uncontrolled extensification in communally-held land and pastoral areas. This incurs societal cost and could undermine the long-term sustainability of the farming system.

The sustainable use of land resources and the successful implementation of policies and programs to improve land productivity would require narrowing the gap and resolving the conflicts between official and local land users. This would require taking into account land users' perspectives, local variations in ecology and socio-cultural conditions, incorporating proven indigenous practices and knowledge into technical approaches, and ensuring local participation in decision-making and strategies to address land degradation.

References

Abel, N.O.J., and P. Blaikie, 1989. "Land Degradation, Stocking Rate and Conservation Policies in the Communal Rangelands of Botswana and Zimbabwe." *Land Degradation and Rehabilitation* 1: 101-123.

Adriaanse, A., 1993. "Environmental Policy Performance Indicators. A Study on the Development of Indicators for Environmental Policy in the Netherlands." Uitgeverij, The Hague.

Ahmed, R., 1993. "Liberalization of Agricultural Inputs Market in Bangladesh." International Fertilizer Development Center, Muscle Shoals, Ala.

Anderson, D. and R. Grove, 1987. *Conservation in Africa: People, Policies, and Practices*. Cambridge: Cambridge University Press.

Badiane, O. and C. Delgado, 1995, *A 2020 Vision for Food, Agriculture, and the Environment.*" International Food Policy Research Institute, Washington, D.C.

Bagachwa, S.D., Shechambo, F.C., Sosovele, H., Kulindwa, K.A., Naho, A.A, and E. Cromwell, 1995. *Structural adjustment and sustainable development in Tanzania.* Tanzania: Dar-Es-Salaam University Press.

Bartels, G.B., B.E. Norton, and G. K. Perrier, 1993. " An Examination of the Carrying Capacity Concept." in Behnke, R.H. Jr., I. Scoones and C. Kerven, *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas*. Overseas Development Institute, International Institute for Environment and Development, Commonwealth Secretariat, UK.

Bassett, T.J., and D. E. Crummey, 1994. *Land in African Agrarian Systems*. Madison: University of Wisconsin Press.

Behnke, R.H. Jr., and I. Scoones, 1993. "Rethinking Range Ecology: Implication for Rangeland Management in Africa. " in Behnke, R.H. Jr., I. Scoones and C. Kerven, *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Overseas Development Institute, International Institute for Environment and Development, Commonwealth Secretariat, UK.

Bie, S. 1990. "Dryland Degradation Measurement Techniques." Environment Working Paper 26, World Bank, Washington, D.C.

Binswanger, H., 1989. "Brazilian Policies that Encourage Deforestation in the Amazon." Environment Department Working Paper No. 16, World Bank, Washington, D.C.

_____, and J. McIntire, 1988. Behavioral and Material Determinants of Production Relations in Agriculture." *Journal of Development Studies* 22(3): 503-39.

Biot, Y. 1991. "How Long Can Livestock Production be Sustained in the Hardveld of Botswana." *Pedologie* 41(2):133-47.

_____, P. M. Blaikie, C. Jackson, R. Plamer-Jones, 1995. "Rethinking Research on Land Degradation in Developing Countries." Discussion Paper, Washington, D.C.: World Bank.

_____, R. Lambert, and S. Perkins, 1991. "What's the Problem? An Essay on Land Degradation, Science and Development in Sub-Saharan Africa." Discussion Paper No. 22, School of Development Studies, University of East Anglia, Norwich, UK.

Blaikie, P. 1982. *The Political Economy of Erosion in Developing Countries*. New York: Longman.

Blaikie, P., and H.C. Brookfield, 1987. *Land Degradation and Society*. London: Methuen.

Borlaug, N., and C.R. Dowswell, 1994. Feeding a human population that increasingly crowds a fragile planet. 15th World Congress of Soil Science, Acapulco, Mexico. Chapingo, Mexico: International Soil Science Society.

Boserup, E. 1981. *Population and Technological Change: A Study of Long-Term Trends*. Chicago: University of Chicago Press.

Brown, L., and W. Wolf, 1985. "Reversing Africa's Decline." World Watch Paper 65, Washington, D.C.: World Watch Institute.

Bruce, J., 1988. "A Perspective on Indigenous Land Tenure Systems and Land Concentration." in R.E. Downs and S. Reyna, eds., *Land and Society in Contemporary Africa*, Hanover, N.H.: University Press of New England.

Bruce, J., and A.E. Migot-Adholla, eds. 1994, *Searching for Land Tenure Security in Africa*. Iowa: Kendall/Hunt Publishing.

Budelman, A., and F. Van Der Pol, 1992. "Farming System Research and the Quest for a Sustainable Agriculture." *Agroforestry System* 19:(3) 187-206.

_____, and P.M. Zander, 1990. "Land use by immigrant Baoule Farmers in the Tai Region, South West Ivory Coast." *Agroforestry System* 11:(2) 101-123.

Bumb, B.L. 1995. "Global Fertilizer Perspective, 1980-2000: The Challenges in Structural Transformation." International Fertilizer Development Center, Muscle Shoals, Ala.

_____, and C. A. Baanante, 1996. "The Role of Fertilizer in Sustaining Food Security and Protecting the Environment to 2020." Food, Agriculture, and Environment Discussion Paper 14, International Food Policy Research Institute, Washington, D.C.

Bureau of Statistics, 1988. *Tanzania 1988 Population Census*. The United Republic of Tanzania, Dar-es-Salaam.

Cernea, M., 1985. *Putting People First: Sociological Variables in Rural Development*. Oxford: Oxford University Press.

Chambers, R., A. Pacey, L.A. Thrupp, 1989. *Farmers First: Farmers Innovation and Agricultural Research*. London: Intermediate Technology Publication.

Chambers, R., 1983. *Rural Development: Putting the Last First*. London: Longman.

Christiansson, C., 1981. *Soil erosion and sedimentation in semi-arid Tanzania: Studies of environmental change and ecological imbalance*. Scandinavian Institute of African Studies, Uppsala, Sweden.

Clay, E.J. and B.P. Schaffer, 1984. *Room for Manoeuvre: An Exploration of Public Policy Planning in Agricultural and Rural Development*. London: Heinemann.

Cleaver, K.M. and G.A. Schreiber, 1994. *Reversing the Spiral: The Population, Agriculture, and Environmental Nexus in Sub-Saharan Africa*. Washington, D.C.: World Bank.

Cohen, M.J., 1980. "Land Tenure and Rural Development in Africa." in Bates R., and M. Lofchie. New York: *Agricultural Development in Africa*. Praeger.

Collinson, M., 1983. *Farm Management in Peasant Agriculture*. Boulder, Colorado: Westview Press.

Conyers, D., 1971. " Agro-economic zones of Dodoma and Singida." BRALUP Research Report No. 47, University of Dar-es-Salaam.

Cook, C., and M. Grut, 1989. *Agroforestry in Sub-Saharan Africa: A Farmer Perspective*. Technical Paper Number 112, Washington, D.C.: World Bank.

Cooper, P.J.M., R.R.B. Leakey, M.R. Roa, and L. Reynolds, 1996. "Agroforestry and the Mitigation of Land Degradation in the Humid and Sub-humid Tropics of Africa." *Experimental Agriculture* 32: 235-290.

Critchely,W.R.S., C. Reij, and T.J. Willcocks, 1994. "Indigenous Soil and Water Conservation." *Land Degradation and Rehabilitation* 5: 293-314.

Crosson, P., and Jock R. Anderson, 1995. *Achieving a Sustainable Agricultural System in Sub-Saharan Africa*. Post-UNCED Series, Building Blocks for Africa 2025, Paper No. 2, Washington, D.C.: World Bank.

Dejene, A., 1990. *Environment, Famine, and Politics in Ethiopia: A View from the Village*. Boulder, Colorado: Lynne Rienner Publisher.

De Pauw, E., 1995. "Development of Land Use Planning and Land Tenure in Tanzania." Main Report, Technical Support Service Project, FAO, Rome.

Dregen, H.E. and N.T. Chou, 1992. "Global Desertification and Cost." in *Degradation and Restoration of Arid Lands*. ed. H.E.Dregen, Texas Tech University, Lubbock, Texas.

Dorner, P., 1972. *Land Reform and Economic Development.* Harmondsworth, England: Penguin.

Food and Agricultural Organization of the United Nations (FAO), 1993. *Agriculture: Towards 2010.* Rome.

_____, 1979: *A Provisional Methodology for Soil Degradation Assessment*. Rome.

Feder, G., and R. Noronha, 1987. "Land Right Systems and Agricultural Development in Sub-Saharan Africa." *World Bank Research Observer* 2:143-69

Fortman, L., 1989. "Peasant and Official Views of Rangeland use in Botswana. Fifty Years of Devastation?" *Land Use Policy* 6(3): 197-202.

Fujisaka, S., 1989. "Participation by Farmers: Research and Extension Workers in Soil Conservation." Gatekeeper Series SA 16, Sustainable Agriculture Programme, International Institute for Environment and Development, London.

Ghai, D. and J. Vivian, 1992. *Grass Root Environmental Action Plan: People's Participation in Sustainable Development*. London: Routledge.

Gillman, C., 1930. "Notes on soil erosion in East Africa." Gillman papers, Hans Cory Collection, University of Dar-es-Salaam.

_____, 1933. "Dodoma Dams." *Ann Rep. Geol. Surv. Tanganyika* 39-42.

_____, 1934. "Dodoma Dams" *Ann Rep. Geol. Surv. Tanganyika* 38-42.

Glantz, M., 1987. *Droughts and Hunger and in Africa, Denying Famine a Future*. Cambridge: Cambridge University Press.

Hammond, A., A. Adriaanse, E. Rodenburgh, D. Bryant, and R. Woodward, 1995. "Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Reform in the Context of Sustainable Development." Washington, D.C.: World Resources Institute.

Hare, F.K., 1985. "Climate Variation, Drought and Desertification." No. 653, World Meteorological Organization, Geneva, Switzerland.

Harrison, P., 1987. *The Greening of Africa*. London: Paladin Grafton Books.

Hartley, B.J., 1938, "An indigenous system of soil protection." *East African Agricultue Journal* 4:63-66.

Holmberg, J., 1991. "Poverty, Environment and Development." Swedish International Development Authority, paper submitted to UNCED, Geneva.

Holtland, G., 1996. "The Potential of Zero-Grazing by Smallholders in Destocked Mvumi Division, Dodoma," in C. Christiansson and I. Kikula, eds., *Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania*. Report 13, Regional Soil Conservation Unit, SIDA, Nairobi.

Hudson, N., 1991. *A Study of the Reason for the Success of Failures of Soil Conservation Projects*. FAO, Rome.

Huijsman, B. and H. Savenije, eds.1991. *Making Haste Slowly: Strengthening Local Environmental Management in Agricultural Development*. Royal Tropical Institute, The Netherlands.

Hurni, H., 1996. *Precious Earth: From Soil and Water Conservation to Sustainable Land Management*. International Soil Conservation Organization, and Center for Development and Environment, University of Berne, Switzerland.

Hurni, H., H.P. Liniger, T. Wachs, and K. Herweg, 1995. World Overview of Conservation Approaches and Technology. Workshop Proceedings, University of Berne, Switzerland.

International Food Policy Research Institute(IFPRI), 1996. *Feeding the World, Preventing Poverty, and Protecting the Eartth: A 2020 Vision*. Washington, D.C.

International Fund for Agricultural Development (IFAD), 1991. "Fertilizer Project Evaluation Report." Rome.

Izac, A.M., and M.J. Swift, 1994. "On Agricultural Sustainability and its Measurement in Small-Scale Farming in Sub-Saharan Africa." *Ecological Economics* 11: 105-125.

Johansson, D. and L. Strömquist, 1977. "Termite mounds near Dodoma. Central Tanzania." Meddelanden fran Uppsala Universitets Geografiska Institution, 272: 101-115.

Kassam, A.H., H.T. van Velthuizen, G.W. Fischer, and M.M. Shah, 1993. "Agroecological Land Resource Assessment for Agricultural Development Planning. A Case Study of Kenya." Resources data base and land productivity. Main report. World Soil Resources 71, FAO, Rome.

Kerario, E., 1996. "A Note on Problems Observed during the Initial Stages of the Zero-Grazing Project in the HADO Project Area of Kondoa." in C. Christiansson and I. Kikula, eds. *Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania*. Regional Soil Conservation Unit, Report 13, SIDA, Nairobi.

Kerario, E. 1994. "Socio-Economic Factors Contributing to Low Adoption of Intensive Livestock Farming in Semi-Arid Areas: A Case of Hado Project, Kondoa, District." Paper presented at the Man-Land Interrelations in Semi-Arid Tanzania Workshop in Dodoma, Tanzania.

Kerkhof, P., 1990. *Agroforestry in Africa: A Survey of Projects*. London: Panos.

Kidd C.V., and D. Pimentel, 1992. *Integrated Resource Management : Agroforestry for Development*. New York: Academic Press, Inc.

Kikula, I.S., and R.B.B. Mwalyosi, 1994. "Environmental Management in Tanzania: Challenges of the 21st Century." in Msambichaka, L.A., Moshi, H.P.B. and Mtatifikolo, F.P. eds., *Development Challenges and Strategies for Tanzania: An Agenda for the 21st Century*. Tanzania: Dar-es-Salaam University Press.

_____, 1996. "Perspective of Research Programme on Man-Land Interrelations in Semi-Arid Tanzania." in Christiansson, C. and I. Kikula, eds. *Changing Environments: esearch on Man-Land Interrelations in Semi-Arid Tanzania*. Report 13, Regional Soil Conservation Unit, SIDA, Nairobi.

Kruger, H.J., B. Fentaw, Y. Gebre Michael, and K. Kejela, 1985. "Inventory of Indigenous Soil and Water Conservation Measures in Ethiopia." Research Report, Soil Conservation Research Progamme, Addis Ababa.

Lal, R. 1995. "Erosion-crop productivity relationship for soils in Africa." *American Journal of Soicial Science Society* 59:661-67.

Leonard, H.J., 1989. *Environment and the Poor: Development Strategies for the Common Agenda*. New Brunswick, N.J: Transaction Books.

Lindberg, C., 1996. "A Case Study in the Relationship between Poverty and Land Degradation in Babati District, Tanzania." in Christiansson, C. and I. Kikula, eds. *Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania*. Report 13, Regional Soil Conservation Unit, SIDA, Nairobi.

Little, P.D., and M. Horowitz, 1987. *Lands at Risks in the Third World: Local Level Perspectives*. Boulder, Colorado: Westview Press.

Loiske, V.M., 1991. "Who has a Reason to Conserve Soil? Lessons from Giting Village, Tanzania." Working Paper No. 12, Environment and Development Studies Unit, School of Geography, Stockholm University.

Ludwig, H.D., 1968. "Permanent Farming on Ukara, Impact of Land Shortage on Husbandry Practices." in Ruthernberg, H. 1968, (ed.); *Smallholder farming and smallholder development in Tanzania*. Munchen, Germany.

Mascarenhas, J., P. Shah, S. Joseph, R. Jayakaraw, V. Ramachandran, A. Fernandez, R. Chambers, and J. Pretty, 1991. "Participatory Rural Appraisal." International Institute for Environment and Development, London.

Mbegu, A.C., 1996. "The Problem of Soil Conservation and Rehabilitation Lessons from the HADO Project." in Christiansson, C. and I. Kikula, eds. *Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania*. Report 13, Regional Soil Conservation Unit, SIDA, Nairobi.

McPherson, M., 1982. "Land Fragmentation: A Selected Literature Review." Discussion Paper No. 141, Harvard Institute for International Development, Cambridge, Massachusetts.

Migot-Adholla, S., P. Hazell, B. Blarel, and F. Place, 1991. "Indigenous Land Rights Systems in Sub-Saharan Africa: A Constraint on Productivity." *World Bank Economic Review* 5: 1, 155-75.

Ministry of Agriculture, 1995. "The National Agricultural Extension Program." Dar-es-Salaam.

_____, 1993. "The National Agricultural and Livestock Extension Rehabilitation Project." Dar-es-Salaam.

Ministry of Lands, Housing and Urban Development (MLHUD), 1995. "National Land Policy." Dar-es-Salaam.

Mohamed, S. ,1996. "Farming Systems in Land Tenure in Haubi Village of the Kondoa District." in Christiansson, C. and I. Kikula, ed., *Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania.* Report 13, Regional Soil Conservation Unit, SIDA, Nairobi.

_____, 1993. "Farming System and Land Tenure Issues in the Kondoa Eroded Area." Institute of Resource Assessment, University of Dar-es-Salaam.

Moore, T.R., 1979. Rainfall Erosivity in East Africa.*Geografiska Annaler* 61A (3-4): 147-156.

Mung'ong'o, C., 1995. "Social Process and Ecology in the Kondoa Irangi Hills, Central Tanzania." Doctoral dissertation, Department of Human Geography, Stockholm University.

Murray-Rust, D.H., 1972. "Soil erosion and reservoir sedimentation in a grazing area west of Arusha. Northern Tanzania." *Geografiska Annaler* 54A (3-4): 325-343.

Nair, P.K.R., 1992. "Agroforestry Systems Design: An Ecozone Approach." in Narendra Sharma, ed. *Managing the World's Forests: Looking for Balance Between Conservation and Development.* Iowa: Kendall/Hun Publishing.

Organization for Economic Cooperation and Development (OECD), 1994. "The Use of Environmental Indicators for Agricultural Policy Analysis." Paris.

Oldeman, L. R., R.T.A. Hakkeling, and W.G. Sombroek, 1990. "World Map of the Status of Human-Induced Soil Degradation: An Explanatory Note." ISRC-UNEP Report, The Netherlands.

_____, V.W.P. van Engelen, and J.H.M. Pulles, 1990. "The Extent of Human Induced Soil Degradation." Annex 5, ISRIC, Wageningen, the Netherlands.

Oldeman, L. R., and V.W.P. van Engelen, 1990. "The Global Assessment of Human-Induced Soil Degradation." ISRIC, Wageningen, The Netherlands.

Östberg, W., 1995. *Land is coming up: The Burunge of Central Tanzania and their Environments,* Department of Social Anthropology, No. 34, Stockholm University, Stockholm.

Oxford University and Sokoine University of Agriculture, 1992. "Agricultural Diversification and Internsification Study." Volume 1 and 2, Dar-es-Salaam.

Payton, R.W. and E.K. Shishira, 1994. "Effects of Soil Erosion and Sedimentation on Land Quality: Defining Pedogenetic Baselines in the Kondoa District of Tanzania." in Syers, J.K., and D. L. Rimmer eds. *Soil Science and Sustainable Land Management in the Tropics.* Wallingford: CAB International.

Payton, R.W., Christiansson, C., Shishira, E.K., Yanda, P.Z., and Eriksson, M.G., 1992. "Landform, soils and erosion in the North-Eastern Irangi Hills, Kondoa, Tanzania." *Geografiska Annaler* 74A: 65-79.

Pieri, C., Julian Dumanski, Ann Hamblin, and Anthony Young, 1995. "Land Quality Indicators." Discussion Paper No. 315, World Bank, Washington, D.C.

Pinstrup-Andersen, P., and R. Pandya-Lorch, 1996. "Alleviating Poverty, Intensifying Agriculture, and Effectively Managing Natural Resources." Food, Agriculture, and Environment Discussion Paper No.14, International Food Policy Research Institute, Washington, D.C.

Place, F., and P. Hazell, 1993. "Productivity Effects of Indigenous Land Tenure Systems in Sub-Saharan Africa." *American Journal of Agricultural Economics* 75(1): 10-19.

Rapp, A., D.H. Murray-Rust, C. Christiansson, and L. Berry, 1972. "Soil Erosion and Sedimentation in Four Catchments near Dodoma, Tanzania." *Geography Annals*, 54 A (3-4): 325-343.

Rapp, A., L. Berry, and P. Temple, 1973. *Studies of soil erosion and sedimentation in Tanzania.* Research Monograph No 1, BRALUP, Dar-es-Salaam.

Ravnborg, H.M.,1992. "Sensing Sustainability: Farmers as Soil Resource Managers." CDR Working Paper 92.6, Center of Development Research, Copenhagen, Denmark.

Richards, P., 1985. *Indigenous Agricultural Revolution: Ecology and Food Production in West Africa.* London: Hutchinson.

Repetto, R. and M. Gillis, eds., 1988. *Public Policies and the Misuse of Forest Resources.* Cambridge University Press.

Ruthenberg, H., 1980. *Farming System in the Tropics.* Oxford: Clarendon Press.

Sanchez, P., 1995. "Science in Agroforestry." *Agroforestry Systems* 30: 5-55.

_____, and R.R.B. Leakey, 1996. "Land-use transformation in Africa: three determinants for balancing food security with natural resource utilization." Paper presented at the 4th Congress of the European Society for Agronomy, The Netherlands.

_____, A. Izac, I. Valencia, and C. Pieri, 1995. "Soil Fertility Replenishment in Africa: A Concept Paper." Proceedings of the Workshop Developing African Agriculture: Greater Impact from Research Investment, Addis Ababa.

Sankhayan, P.L. 1995. "Fertilizer Marketing, Distribution and Use under Structural Adjustment Programmes in Tanzania." Ecology and Development Paper No. 16, Agricultural University of Norway, Ås, Norway.

Scherr, S.J. and S. Yadav, 1996. "Land Degradation in Developing World: Implications for Food, Agriculture, and the Environment to 2020." Food, Agriculture, and Environment Discussion Paper No. 14, International Food Policy Research Institute, Washington, D.C.

Sconnes, I, 1993. "Why are there so Many Animals? Cattle Population Dynamics in the Communal Areas of Zimbabwe." in Behnke, R.H., I. Scoones and C. Kerven, *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Overseas Development Institute, International Institute for Environment and Development, Commonwealth Secretariat, UK.

Sharma, N., S. Denning, and K. Cleaver, 1995. "Restoration of Soil Fertility in Sub-Saharan Africa, Concept Paper and Action Plan." Africa Region , World Bank, Washington, D.C.

Shayo, C.M., and J. A. Kategile, 1992. "Introduction of Dairy Cattle Production System in Soil Conservation Areas." International Livestock Center for Africa, Addis Ababa.

Shayo, C.M., T. Gebregziabher, J.I. Mkonyi, S. Das, J. Bwire, H.A. Ulotu, and E.T.R. Lyatuu, 1993. "Intensive Smallholder Dairy Production Systems in Semi-Arid Central Tanzania: Kondoa Eroded Areas." Proceedings of a seminar held at the Arusha International Conference Center, Tanzania, 27-28 September, Zonal Research and Training Center, Mpwapwa, Tanzania.

Shishira, E., and R. Payton, 1996. " The Causes and Effects of Accelerated Soil Erosion and Sedimentation in the Kondoa Eroded Area: Evidence from the Lake Haubi Basin, Kondoa District, Tanzania." in Christiansson, C. and I. Kikula, eds. *Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania*, Report No. 13, Regional Soil Conservation Unit, SIDA, Nairobi.

Spooner, B. and H.S. Mann, 1982. *Desertification and Development: Dry Land Ecology in Social Perspective.* London: Academic Press.

Staples, R.R. 1936. " Runoff and soil erosion tests in semi-arid Tanganyika Territory." *Ann. Rep. Dep. Vet. Sci. Anim. Husb* 2: 134-142.

_____,1939. " Combating soil erosion in the central province of Tanganyika Territory." *East African Agricultural Journal* 7 (1): 156-163.

_____, 1942. "Combating Soil Erosion in the Central Province of Tanganyika Territory." *East African Agricultural Journal* 7 (2): 189-195.

Stoorvogel, J.J. and E.M.A Smaling, 1990. "Assessment of Soil Nutrient Depletion in Sub-Saharan Africa." Report 28, Wageningen, the Netherlands.

Strömquist, L. and D. Johansson, 1978. "Studies of soil erosion and sediment transport in the Mtera reservoir region, Central Tanzania." *Zeitschrift fur Geomorph, N. F. Suppl. Bd* 29: 43-51.

Thornton, D. and N.V. Rounce, 1936. " Ukara Island and agricultural practices of the Wakara." *East Africa Agric. Journal*, Vol 2.

Thrupp, A. 1996. *New Partnerships for Sustainable Agriculture*. World Resource Institute, Washington, D.C.

Timberlake, L., 1986. Africa in Crisis: *The Causes, the Cures of Environmental Bankruptcy*. London: Earthscan.

Toulmin, C., 1991. "Bridging the Gap between Top-down and Bottom-up in Natural Resource Management." Scandinavian Institute of African Studies, Uppsala, Sweden.

United Nations Conference on Environment and Development, 1992. *Agenda 21, the Earth Summit,* Rio de Janerio, Brazil.

Van Rensburg, H.J, 1955. " Runoff and soil erosion tests of Mpwapwa" Central Tanganyika. *East . Africa Agriculture Journal* 20 (4): 228-231.

Watts, M., 1985. "Social Theory and Environmental Degradation." in Gradus, Y. ed., *Desert Development: Man and Technology in Sparselands.* Reidel Publishing.

Wommer, P.L, and M.J. Swift, 1994. *The Biological Management of Tropical Soil Fertility.* New York: John Wiley and Sons.

World Bank, 1991. "Tanzania: Forest Resource Management." Washington, D.C.

_____, 1992. *World Development Report 1992: Development and the Environment.* New York: Oxford University Press.

_____, 1993. "Tanzania - Poverty Profile." Population and Human Resources Division, Eastern Africa Department, Washington, D.C.

World Bank, 1994. "Tanzania: Agricultural Sector Memorandum." Volume 2, Main Report, Washington, D.C.

_____, 1996. *World Bank Participation Source Book.* Washington, D.C.

World Bank and FAO, 1995. "Recapitalization of Soil Productivity in Sub-Saharan Africa." Discussion Paper, Rome.

Yates, R.A., and A. Kiss, 1992. "Using and Sustaining Africa's Soils." Agricultural and Rural Development Series No. 6, Technical Department, Africa Region, World Bank, Washington, D.C.

Yanda, P.Z., 1995. "Temporal and Spatial Variations in Soil Degradation in Mwisanga Catchment, Kondoa, Tanzania." Ph.D. Thesis Series No. 4, Department of Physical Geography, Stockholm University.

Young, A., 1989. *Agroforestry for Soil Conservation.* Nariobi: CAB International/ICRAF.

APPENDIX A

HOUSEHOLD QUESTIONNAIRE TO ASSESS LAND DEGRADATION IN KONDOA DISTRICT, TANZANIA

Name of Village :_____

I. Major Issue: Soil Erosion

1. Do you perceive the problem of soil erosion on your land?

(i) yes ----------

(ii) no ----------

2. If yes, what features lead you to believe that such problem exists?

(i) ----------

(ii) ----------

(iii)----------

3. Do you observe change in the level of stoniness in your cultivated land?

(i) yes ----------

(ii) no ----------

4. If yes, has it been increasing or remained the same?

(i) increased ----------

(ii) remained the same ----------

5. Do you observe appearances of plant species that signify the severity of erosion?

(i) yes ----------

(ii) no ----------

6. If yes, what are the names of these species?

Local Name	Scientific Name
(i) ----------	----------
(ii) ----------	----------
(iii) ----------	----------

7. Do you use some kind of measure or practice to control soil erosion?

(i) yes ----------

(ii) no ----------

8. If yes, which of the following measures do you practice?

(i) cultivation along the contour

(ii) terracing

(iii) strip-cropping along the contour

(iv) bunding

(v) windbreaks

(vi) vegetative and crop cover

(vii) grassed waterways

(viii) tree planting

(ix) check dams

(x) other (specify) ----------

9. Have you taken any of the following measures because of erosion?

(i) abandoned your cultivated land? yes----- no-----

(ii) expanded to marginal land? yes---- (type) ---------- no-----

(iii) have taken off-farm employment? yes----- no-----

(iv) other (specify) ----------

II. Major Issue: Soil Fertility

10. Do you perceive the problem of soil fertility decline on your cultivated land?

(i) yes ----------

(ii) no ----------

11. If yes, has it been:

(i) increasing ----------

(ii) decreasing ----------

(iii) unchanged ----------

12. What features leads you to believe that such problem exists?

(i) ----------

(ii) ----------

(iii) ----------

13. Do you observe change in the level of crop yield on your cultivated land?

(i) yes ----------

(ii) no ----------

14. If yes, has it been increasing or declining?

(i) increased ----------

(ii) declined ----------

15. If increasing or declining what are the major reasons?

(i) ----------

(ii) ----------

(iii) ----------

16. Do you observe appearances of plant species that signify decline in soil fertility?

(i) yes ----------

(ii) no ----------

17. If yes, what are the names of these species?

Local Name	Scientific Name
(i) ----------	----------
(ii) ----------	----------
(iii) ----------	----------

18. Do you use some kinds of practices to maintain or enrich soil fertility of your cultivated land?

(i) yes ----------

(ii) no ----------

19. If yes, which of the following practices do you use?

(i) use of fertilizer

(ii) use of manure

(iii) intercropping

(iv) mulch or compost

(v) agroforestry

(vi) others (specify) ----------

20. If you use fertilizer, what kind of fertilizers do you use?

---

21. How much do you pay for 50 kg of fertilizer including transport?

---

22. Has your fertilizer use increased, decreased, or remained the same?

(i) increased ----------

(ii) declined ----------

(iii) remained the same ----------

23. What are the reasons for this change?

(i) ----------

(ii) ----------

(iii) ----------

24. Does investment in fertilizer use benefit you?

(i) yes ----------

(ii) no ---------

25. Is fertilizer readily available in your village?

(i) yes ----------

(ii) no ---------

26. Do you use improved seed?

(i) yes ----------

(ii) no ---------

27. If yes, for which crops?

---

28. How often have you experienced drought and famine in this area?

(i) once in 3 years ----------

(ii) once 5 years ----------

(iii) once in 10 years ----------

(iv) other (specify) ----------

29. What measures do you take in times of drought and famine?

(i) ----------

(ii) ----------

(iii) ----------

30. Have you received relief or food assistance from the government or other sources in times of drought or famine?

(i) yes ----------

(ii) no ----------

31. Which months of the year are often associated with food shortage?

III. Major Issue: Land Availability

32. How many people live in your household? ----------

(i) small children ----------

(ii) adults ----------

(iii) old age/disabled ----------

33. What is the total area of your cultivated land?

----------Ha

34. Are you cultivating all your land?

(i) yes ----------

(ii) no ----------

35. If no, what are the reasons?

(i) ----------

(ii) ----------

(iii) ----------

36. Are all your fields in one unit?

(i) yes ----------

(ii) no ----------

37. What is the distance from your home to the most fertile plot? ----------

38. What is the distance from your home to a less fertile plot? ----------

39. Has the size of your cultivated land changed?

(i) yes ----------

(ii) no ----------

40. If yes, has it:

(i) increased ----------

(ii) declined ----------

(iii) remained the same ----------

41. If it has decreased, what are the reasons?

(i) ----------

(ii) ----------

42. How do you address this problem? (solutions)

(i) ----------

(ii) ----------

(iii) ----------

43. If your cultivated land has expanded, is the newly cultivated land as productive as the previous one?

(i) Same ----------

(ii) More productive ----------

(iii) Less productive ----------

44. How far is this newly cultivated land from your homestead? ----------

45. How many days does it take you to clear 1 Ha of new land? ----------

IV. Farming Practices

46. What are the major crops grown on your farm in order of importance?

(i) ----------

(ii) ----------

(iii) ----------

47. Do you grow each of these crops alone or do you mix them with other crops?

(i) alone ----------

(ii) with other crops (name the most common combinations)

48. Do you plant the same crop every year or change to other crops or practice fallowing?

(i) plant the same crop each year ----------

(ii) change to other crops ----------

(iii) practice fallow ----------

(iv) change to other crops and then practice fallow ----------

49. Tillage practice used by farmer

(i) hand labor----- family labor---- hired labor----- what season---

(ii) drought power------- owned------- hired----------

(iii) tractor------- owned---------- hired----------

50. What do you do with your crop residue?

(i) burn them ----------

(ii) use them as feed ----------

(iii) use them for cooking ----------

(iv) others (specify) ----------

51. Do you use irrigation in any of your plots?

(i) yes ----------

(ii) no ----------

52. If yes, what crops ?

(i) rice ----------

(ii) vegetables ----------

(iii) maize ----------

(iv) sugar cane ----------

(v) other (specify) ----------

53. Do you use fire as part of your land management practices?

(i) yes ----------

(ii) no ----------

54. If yes, name type of use?

(i) clearing of new land ----------

(ii) clearing of weeds ----------

(iii) pasture regrowth ----------

55. Your livelihood mainly depends on:

(i) cropping only ----------

(ii) both cropping and livestock ----------

(iii) livestock only ----------

56. If you have livestock , indicate type and number?

Type	No.	Use	Zero Grazing? (yes or no)
(i) ----------	------	----------	------
(ii) ----------	------	----------	------
(iii) ----------	------	----------	------

57. Do you grow trees on your farm?

(i) yes ----------

(ii) no ----------

58. If yes, for what purposes?

(i) fuelwood --------- tree type ----------

(ii) building materials ------- tree type ----------

(iii) fodder --------- tree type ----------

(iv) soil fertility maintenance ------ tree type ----------

(v) fruits or nuts ----- tree type ----------

(vi) windbreaks ------ tree type ----------

(vii) shades ---------- tree type ----------

V. Major Issue: Stocking Rate

59. Do you have shortage of pasture or feed for livestock?

(i) yes ----------

(ii) no ----------

60. If yes, which are the critical months?

---

61. How do you deal with this problem?

(i) ----------

(ii) ----------

62. If you have shortage of pasture, do you think that decreasing the number of livestock will help solve this problem?

(i) yes ----------

(ii) no ----------

63. How many permanent watering points do you have in the village? ----------

64. What is the most common type of permanent watering points used in your village?

---

65. Do you observe the emergence of unpalatable pasture species in the grazing areas?

(i) yes ----------

(ii) no ----------

66. If yes, what are the names of these species?

Local Name	Scientific Name
(i) ----------	----------
(ii) ----------	----------
(iii) ----------	----------

VI. Major Issue: Land Tenure

67. Do you feel secure that the land you cultivate belongs to you?

(i) yes ----------

(ii) no ----------

68. If no, what are the reasons?

(i) ----------

(ii) ----------

69. Is investment on land profitable?

(i) yes ----------

(ii) no ----------

70. If yes, what kind of improvement or investment have you made?

(i) ----------

(ii) ----------

(ii) ----------

71. Have you ever had conflict regarding the ownership of the land you work?

(i) yes ----------

(ii) no ----------

72. Have you experienced conflict over grazing rights?

(i) yes ----------

(ii) no ----------

73. If yes, who did it involve?

(i) pastoralist ----------

(ii) farmer ----------

VII. Major Issue: Availability of Household Energy

74. What is the primary source of your fuel?

(i) fuelwood ----------

(ii) crop residue ----------

(iii) dung ----------

(iv) kerosene ----------

(v) other (specify) --------

75. Indicate the time and distance you travel to collect the primary source of fuel?

(i) time ----------

(ii) distance ----------

76. If you are buying these energy sources locally, have the prices you pay been:

(i) increasing --------

(ii) decreasing --------

(iii) remained the same---------

77. If you face fuelwood shortage, what are the reasons?

(i) ----------

(ii) ----------

78. What measures are you taking to deal with this problem?

(i) agroforestry ----------

(ii) private tree planting ----------

(iii) communal tree planting ----------

(iv) natural regeneration ----------

(v) use of energy saving devices ----------

(vi) other (specify) ----------

VIII. Major Issue: Institutional Capacity

79. Do you belong to a farmer association or some kind of local association?

(i) yes ----------

(ii) no ----------

80. If yes, indicate names and their main activities?

Names	Activities
---	---
---	---
---	---

81. Have you been involved in some capacity in one of the projects in your area? Did you benefit from these projects?

Project	Type of involvement	Benefited? (yes/no)
(i) ---	---	---
(ii) ---	---	---
(iii) ---	---	---

82. How often does an extension agent visit you in a year?

Type of extension agent	# of visit per year
(i) Agricultural extension officer	----------
(ii) Livestock officer	----------
(iii) Cooperative officer	----------
(Iv) Community development officer	----------

83. Do you find the advice you get from the extension agent helpful?

(i) yes ----------

(ii) no ----------

Distributors of World Bank Publications

Prices and credit terms vary from country to country. Consult your local distributor before placing an order.

ARGENTINA
Oficina del Libro Internacional
Av. Cordoba 1877
1120 Buenos Aires
Tel: (54 1) 815-8354
Fax: (54 1) 815-8156

AUSTRALIA, FIJI, PAPUA NEW GUINEA, SOLOMON ISLANDS, VANUATU, AND WESTERN SAMOA
D.A. Information Services
648 Whitehorse Road
Mitcham 3132
Victoria
Tel: (61) 3 9210 7777
Fax: (61) 3 9210 7788
E-mail: service@dadirect.com.au
URL: http://www .dadirect.com.au

AUSTRIA
Gerold and Co.
Weihburggasse 26
A-1011 Wien
Tel: (43 1) 512-47-31-0
Fax: (43 1) 512-47-31-29
URL: http://www .gerold.co/at.online

BANGLADESH
Micro Industries Development Assistance Society (MIDAS)
House 5, Road 16
Dhanmondi R/Area
Dhaka 1209
Tel: (880 2) 326427
Fax: (880 2) 811188

BELGIUM
Jean De Lannoy
Av. du Roi 202
1060 Brussels
Tel: (32 2) 538-5169
Fax: (32 2) 538-0841

BRAZIL
Publicacões Tecnicas Internacionais Ltda.
Rua Peixoto Gomide, 209
01409 Sao Paulo, SP.
Tel: (55 11) 259-6644
Fax: (55 11) 258-6990
E-mail: postmaster@pti.uol.br
URL: http://www .uol.br

CANADA
Renouf Publishing Co. Ltd.
5369 Canotek Road
Ottawa, Ontario K1J 9J3
Tel: (613) 745-2665
Fax: (613) 745-7660
E-mail: order .dept@renoufbooks.com
URL: http:// www .renoufbooks.com

CHINA
China Financial & Economic Publishing House
8, Da Fo Si Dong Jie
Beijing
Tel: (86 10) 6333-8257
Fax: (86 10) 6401-7365

COLOMBIA
Infoenlace Ltda.
Carrera 6 No. 51-21
Apartado Aereo 34270
Santafé de Bogotá, D.C.
Tel: (57 1) 285-2798
Fax: (57 1) 285-2798

COTE D'IVOIRE
Center d'Edition et de Diffusion Africaines (CEDA)
04 B.P. 541
Abidjan 04
Tel: (225) 24 6510;24 6511
Fax: (225) 25 0567

CYPRUS
Center for Applied Research
Cyprus College
6, Diogenes Street, Engomi
P.O. Box 2006
Nicosia
Tel: (357 2) 44-1730
Fax: (357 2) 46-2051

CZECH REPUBLIC
National Information Center
prodejna, Konviktska 5
CS – 113 57 Prague 1
Tel: (42 2) 2422-9433
Fax: (42 2) 2422-1484
URL: http://www .nis.cz/

DENMARK
SamfundsLitteratur
Rosenoerns Allé 11
DK-1970 Frederiksberg C
Tel: (45 31) 351942
Fax: (45 31) 357822
URL: http://www.sl.cbs.dk

ECUADOR
Libri Mundi
Libreria Internacional
P.O. Box 17-01-3029
Juan Leon Mera 851
Quito
Tel: (593 2) 521-606; (593 2) 544-185
Fax: (593 2) 504-209
E-mail: librimu1@librimundi.com.ec
E-mail: librimu2@librimundi.com.ec

EGYPT, ARAB REPUBLIC OF
Al Ahram Distribution Agency
Al Galaa Street
Cairo
Tel: (20 2) 578-6083
Fax: (20 2) 578-6833

The Middle East Observer
41, Sherif Street
Cairo
Tel: (20 2) 393-9732
Fax: (20 2) 393-9732

FINLAND
Akateeminen Kirjakauppa
P.O. Box 128
FIN-00101 Helsinki
Tel: (358 0) 121 4418
Fax: (358 0) 121-4435
E-mail: akatilaus@stockmann.fi
URL: http://www .akateeminen.com/

FRANCE
World Bank Publications
66, avenue d'Iéna
75116 Paris
Tel: (33 1) 40-69-30-56/57
Fax: (33 1) 40-69-30-68

GERMANY
UNO-Verlag
Poppelsdorfer Allee 55
53115 Bonn
Tel: (49 228) 212940
Fax: (49 228) 217492

GREECE
Papasotiriou S.A.
35, Stoumara Str.
106 82 Athens
Tel: (30 1) 364-1826
Fax: (30 1) 364-8254

HAITI
Culture Diffusion
5, Rue Capois
C.P. 257
Port-au-Prince
Tel: (509) 23 9260
Fax: (509) 23 4858

HONG KONG, MACAO
Asia 2000 Ltd.
Sales & Circulation Department
Seabird House, unit 1101-02
22-28 Wyndham Street, Central
Hong Kong
Tel: (852) 2530-1409
Fax: (852) 2526-1107
E-mail: sales@asia2000.com.hk
URL: http://www .asia2000.com.hk

HUNGARY
Euro Info Service
Margitszgeti Europa Haz
H-1138 Budapest
Tel: (36 1) 111 6061
Fax: (36 1) 302 5035
E-mail: euroinfo@mail.matav.hu

INDIA
Allied Publishers Ltd.
751 Mount Road
Madras - 600 002
Tel: (91 44) 852-3938
Fax: (91 44) 852-0649

INDONESIA
Pt. Indira Limited
Jalan Borobudur 20
P.O. Box 181
Jakarta 10320
Tel: (62 21) 390-4290
Fax: (62 21) 390-4289

IRAN
Ketab Sara Co. Publishers
Khaled Eslamboli Ave., 6th Street
Delafrooz Alley No. 8
P.O. Box 15745-733
Tehran 15117
Tel: (98 21) 8717819; 8716104
Fax: (98 21) 8712479
E-mail: ketab-sara@neda.net.ir

Kowkab Publishers
P.O. Box 19575-511
Tehran
Tel: (98 21) 258-3723
Fax: (98 21) 258-3723

IRELAND
Government Supplies Agency
Oifig an tSoláthair
4-5 Harcourt Road
Dublin 2
Tel: (353 1) 661-3111
Fax: (353 1) 475-2670

ISRAEL
Yozmot Literature Ltd.
P.O. Box 56055
3 Yohanan Hasandlar Street
Tel Aviv 61560
Tel: (972 3) 5285-397
Fax: (972 3) 5285-397

R.O.Y. International
PO Box 13056
Tel Aviv 61130
Tel: (972 3) 5461423
Fax: (972 3) 5461442
E-mail: royil@netvision.net.il

Palestinian Authority/Middle East Index Information Services
P.O.B. 19502 Jerusalem
Tel: (972 2) 6271219
Fax: (972 2) 6271634

ITALY
Licosa Commissionaria Sansoni SPA
Via Duca Di Calabria, 1/1
Casella Postale 552
50125 Firenze
Tel: (55) 645-415
Fax: (55) 641-257
E-mail: licosa@ftbcc.it
URL: http://www .ftbcc.it/licosa

JAMAICA
Ian Randle Publishers Ltd.
206 Old Hope Road, Kingston 6
Tel: 809-927-2085
Fax: 809-977-0243
E-mail: irpl@colis.com

JAPAN
Eastern Book Service
3-13 Hongo 3-chome, Bunkyo-ku
Tokyo 113
Tel: (81 3) 3818-0861
Fax: (81 3) 3818-0864
E-mail: orders@svt-ebs.co.jp
URL: http://www .bekkoame.or.jp/~svt-ebs

KENYA
Africa Book Service (E.A.) Ltd.
Quaran House, Mfangano Street
P.O. Box 45245
Nairobi
Tel: (254 2) 223 641
Fax: (254 2) 330 272

KOREA, REPUBLIC OF
Daejon Trading Co. Ltd.
P.O. Box 34, Youida, 706 Seoun Bldg
44-6 Youido-Dong, Yeongchengpo-Ku
Seoul
Tel: (82 2) 785-1631/4
Fax: (82 2) 784-0315

MALAYSIA
University of Malaya Cooperative Bookshop, Limited
P.O. Box 1127
Jalan Pantai Baru
59700 Kuala Lumpur
Tel: (60 3) 756-5000
Fax: (60 3) 755-4424

MEXICO
INFOTEC
Av. San Fernando No. 37
Col. Toriello Guerra
14050 Mexico, D.F.
Tel: (52 5) 624-2800
Fax: (52 5) 624-2822
E-mail: infotec@rtn.net.mx
URL: http://rtn.net.mx

NEPAL
Everest Media International Services (P.) Ltd.
GPO Box 5443
Kathmandu
Tel: (977 1) 472 152
Fax: (977 1) 224 431

NETHERLANDS
De Lindeboom/InOr-Publikaties
P.O. Box 202, 7480 AE Haaksbergen
Tel: (31 53) 574-0004
Fax: (31 53) 572-9296
E-mail: lindeboo@worldonline.nl
URL: http://www .worldonline.nl/~lindeboo

NEW ZEALAND
EBSCO NZ Ltd.
Private Mail Bag 99914
New Market
Auckland
Tel: (64 9) 524-8119
Fax: (64 9) 524-8067

NIGERIA
University Press Limited
Three Crowns Building Jericho
Private Mail Bag 5095
Ibadan
Tel: (234 22) 41-1356
Fax: (234 22) 41-2056

NORWAY
NIC Info A/S
Book Department, Postboks 6512 Etterstad
N-0606 Oslo
Tel: (47 22) 97-4500
Fax: (47 22) 97-4545

PAKISTAN
Mirza Book Agency
65, Shahrah-e-Quaid-e-Azam
Lahore 54000
Tel: (92 42) 735 3601
Fax: (92 42) 576 3714

Oxford University Press
5 Bangalore Town
Sharae Faisal
PO Box 13033
Karachi-75350
Tel: (92 21) 446307
Fax: (92 21) 4547640
E-mail: oup@oup.khi.erum.com.pk

Pak Book Corporation
Aziz Chambers 21, Queen's Road
Lahore
Tel: (92 42) 636 3222; 636 0885
Fax: (92 42) 636 2328
E-mail: pbc@brain.net.pk

PERU
Editorial Desarrollo SA
Apartado 3824, Lima 1
Tel: (51 14) 285380
Fax: (51 14) 286628

PHILIPPINES
International Booksource Center Inc.
1127-A Antipolo St, Barangay, Venezuela
Makati City
Tel: (63 2) 896 6501; 6505; 6507
Fax: (63 2) 896 1741

POLAND
International Publishing Service
Ul. Piekna 31/37
00-677 Warzawa
Tel: (48 2) 628-6089
Fax: (48 2) 621-7255
E-mail: books%ips@ikp.atm.com.pl
URL: http://www .ipscg.waw.pl/ips/export/

PORTUGAL
Livraria Portugal
Apartado 2681, Rua Do Carmo 70-74
1200 Lisbon
Tel: (1) 347-4982
Fax: (1) 347-0264

ROMANIA
Compani De Librarii Bucuresti S.A.
Str. Lipscani no. 26, sector 3
Bucharest
Tel: (40 1) 613 9645
Fax: (40 1) 312 4000

RUSSIAN FEDERATION
Isdatelstvo <Ves Mir>
9a, Lolpachniy Pereulok
Moscow 101831
Tel: (7 095) 917 87 49
Fax: (7 095) 917 92 59

SINGAPORE, TAIWAN, MYANMAR, BRUNEI
Asahgate Publishing Asia Pacific Pte. Ltd.
41 Kallang Pudding Road #04-03
Golden Wheel Building
Singapore 349316
Tel: (65) 741-5166
Fax: (65) 742-9356
E-mail: ashgate@asianconnect.com

SLOVENIA
Gospodarski Vestnik Publishing Group
Dunajska cesta 5
1000 Ljubljana
Tel: (386 61) 133 83 47; 132 12 30
Fax: (386 61) 133 80 30
E-mail: repansekj@gvestnik.si

SOUTH AFRICA, BOTSWANA
International Subscription Service
P.O. Box 41095
Craighall
Johannesburg 2024
Tel: (27 11) 880-1448
Fax: (27 11) 880-6248
E-mail: iss@is.co.za

SPAIN
Mundi-Prensa Libros, S.A.
Castello 37
28001 Madrid
Tel: (34 1) 431-3399
Fax: (34 1) 575-3998
E-mail: libreria@mundiprensa.es
URL: http://www .mundiprensa.es/

Mundi-Prensa Barcelona
Consell de Cent, 391
08009 Barcelona
Tel: (34 3) 488-3492
Fax: (34 3) 487-7659
E-mail: barcelona@mundiprensa.es

SRI LANKA, THE MALDIVES
Lake House Bookshop
100, Sir Chittampalam Gardiner Mawatha
Colombo 2
Tel: (94 1) 32105
Fax: (94 1) 432104
E-mail: LHL@sri.lanka.net

SWEDEN
Wennergren-Williams AB
P. O. Box 1305
S-171 25 Solna
Tel: (46 8) 705-97-50
Fax: (46 8) 27-00-71
E-mail: mail@wwi.se

SWITZERLAND
Librairie Payot Service Institutionnel
Côtes-de-Montbenon 30
1002 Lausanne
Tel: (41 21) 341-3229
Fax: (41 21) 341-3235

ADECO Van Diermen EditionsTechniques
Ch. de Lacuez 41
CH1807 Blonay
Tel: (41 21) 943 2673
Fax: (41 21) 943 3605

TANZANIA
Oxford University Press
Maktaba Street, PO Box 5299
Dar es Salaam
Tel: (255 51) 29209
Fax: (255 51) 46822

THAILAND
Central Books Distribution
306 Silom Road
Bangkok 10500
Tel: (66 2) 235-5400
Fax: (66 2) 237-8321

TRINIDAD & TOBAGO, AND THE CARRIBBEAN
Systematics Studies Unit
9 Watts Street
Curepe
Trinidad, West Indies
Tel: (809) 662-5654
Fax: (809) 662-5654
E-mail: tobe@trinidad.net

UGANDA
Gustro Ltd.
PO Box 9997, Madhvani Building
Plot 16/4 Jinja Rd.
Kampala
Tel: (256 41) 254 763
Fax: (256 41) 251 468

UNITED KINGDOM
Microinfo Ltd.
P.O. Box 3, Alton, Hampshire GU34 2PG
England
Tel: (44 1420) 86848
Fax: (44 1420) 89889
E-mail: wbank@ukminfo.demon.co.uk
URL: http://www .microinfo.co.uk

VENEZUELA
Tecni-Ciencia Libros, S.A.
Centro Cuidad Comercial Tamanco
Nivel C2, Caracas
Tel: (58 2) 959 5547; 5035; 0016
Fax: (58 2) 959 5636

ZAMBIA
University Bookshop, University of Zambia
Great East Road Campus
P.O. Box 32379
Lusaka
Tel: (260 1) 252 576
Fax: (260 1) 253 952

ZIMBABWE
Longman Zimbabwe (Pvt.)Ltd.
Tourle Road, Ardbennie
P.O. Box ST125
Southerton
Harare
Tel: (263 4) 6216617
Fax: (263 4) 621670

06/18/97

RECENT WORLD BANK TECHNICAL PAPERS *(continued)*

No. 322 Peters, *The Ecology and Management of Non-Timber Forest Resources*

No. 323 Pannier, editor, *Corporate Governance of Public Enterprises in Transitional Economies*

No. 324 Cabraal, Cosgrove-Davies, and Schaeffer, *Best Practices for Photovoltaic Household Electrification Programs*

No. 325 Bacon, Besant-Jones, and Heidarian, *Estimating Construction Costs and Schedules: Experience with Power Generation Projects in Developing Countries*

No. 326 Colletta, Balachander, and Liang, *The Condition of Young Children in Sub-Saharan Africa: The Convergence of Health, Nutrition, and Early Education*

No. 327 Valdés and Schaeffer in collaboration with Martín, *Surveillance of Agricultural Price and Trade Policies: A Handbook for Paraguay*

No. 328 De Geyndt, *Social Development and Absolute Poverty in Asia and Latin America*

No. 329 Mohan, editor, *Bibliography of Publications: Technical Department, Africa Region, July 1987 to April 1996*

No. 332 Pohl, Djankov, and Anderson, *Restructuring Large Industrial Firms in Central and Eastern Europe: An Empirical Analysis*

No. 333 Jha, Ranson, and Bobadilla, *Measuring the Burden of Disease and the Cost-Effectiveness of Health Interventions: A Case Study in Guinea*

No. 334 Mosse and Sontheimer, *Performance Monitoring Indicators Handbook*

No. 335 Kirmani and Le Moigne, *Fostering Riparian Cooperation in International River Basins: The World Bank at Its Best in Development Diplomacy*

No. 336 Francis, with Akinwumi, Ngwu, Nkom, Odihi, Olomajeye, Okunmadewa, and Shehu, *State, Community, and Local Development in Nigeria*

No. 338 Young, *Measuring Economic Benefits for Water Investments and Policies*

No. 339 Andrews and Rashid, *The Financing of Pension Systems in Central and Eastern Europe: An Overview of Major Trends and Their Determinants, 1990-1993*

No. 340 Rutkowski, *Changes in the Wage Structure during Economic Transition in Central and Eastern Europe*

No. 341 Goldstein, Preker, Adeyi, and Chellaraj, *Trends in Health Status, Services, and Finance: The Transition in Central and Eastern Europe, Volume I*

No. 343 Kottelat and Whitten, *Freshwater Biodiversity in Asia, with Special Reference to Fish*

No. 344 Klugman and Schieber with Heleniak and Hon, *A Survey of Health Reform in Central Asia*

No. 345 Industry and Mining Division, Industry and Energy Department, *A Mining Strategy for Latin America and the Caribbean*

No. 347 Stock and de Veen, *Expanding Labor-based Methods for Road Works in Africa*

No. 350 Buscaglia and Dakolias, *Judicial Reform in Latin American Courts: The Experience in Argentina and Ecuador*

No. 352 Allison and Ringold, *Labor Markets in Transition in Central and Eastern Europe, 1989-1995*

No. 353 Ingco, Mitchell, and McCalla, *Global Food Supply Prospects, A Background Paper Prepared for the World Food Summit, Rome, November 1996*

No. 354 Subramanian, Jagannathan, and Meinzen-Dick, *User Organizations for Sustainable Water Services*

No. 355 Lambert, Srivastava, and Vietmeyer, *Medicinal Plants: Rescuing a Global Heritage*

No. 356 Aryeetey, Hettige, Nissanke, and Steel. *Financial Market Fragmentation and Reforms in Sub-Saharan Africa*

No. 357 Adamolekun, de Lusignan, and Atomate, editors, *Civil Service Reform in Francophone Africa: Proceedings of a Workshop Abidjan, January 23-26, 1996*

No. 358 Ayres, Busia, Dinar, Hirji, Lintner, McCalla, and Robelus, *Integrated Lake and Reservoir Management: World Bank Approach and Experience*

No. 360 Salman, *The Legal Framework for Water Users' Associations: A Comparative Study*

No. 361 Laporte and Ringold, *Trends in Education Access and Financing during the Transition in Central and Eastern Europe*

No. 362 Foley, Floor, Madon, Lawali, Montagne, and Tounao, *The Niger Household Energy Project: Promoting Rural Fuelwood Markets and Village Management of Natural Woodlands*

No. 364 Josling, *Agricultural Trade Policies in the Andean Group: Issues and Options*

No. 365 Pratt, Le Gall, and de Haan, *Investing in Pastoralism: Sustainable Natural Resource Use in Arid Africa and the Middle East.*

No. 366 Carvalho and White, *Combining the Quantitative and Qualitative Approaches to Poverty Measurement and Analysis: The Practice and the Potential*

No. 367 Colletta and Reinhold, *Review of Early Childhood Policy and Programs in Sub-Saharan Africa*

THE WORLD BANK

1818 H Street, N.W.
Washington, D.C. 20433 USA

Telephone: 202-477-1234

Facsimile: 202-477-6391

Telex: MCI 64145 WORLDBANK
MCI 248423 WORLDBANK

Cable Address: INTBAFRAD
WASHINGTONDC

World Wide Web: http://www.worldbank.org/

E-mail: books@worldbank.org

13993 AGR
0-8213-3993-1
Land Degradation in Tanzani
9 $ 22.00 1540
ISBN 0-8213-3993-1