IFPRI Eastern Africa Food Policy Network

The Future of Smallholder Farming in Eastern Africa

The Roles of States, Markets, and Civil Society

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The Future of Smallholder Agriculture in Eastern Africa: The Roles of States, Markets, and Civil Society

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Foreword

When the IFPRI Eastern Africa Food Policy Network was launched in 1998, IFPRI and its partners hoped the Network would catalyze stronger independent food and agricultural policy research efforts in the region, capacity strengthening, and improved communication of research results to the local policy community. The original goals of the Network were therefore threefold: first, to generate policy-relevant information through collaborative research activities; second, to improve the dissemination and use of such information; and, third, to strengthen the capacity to undertake and communicate policy research and analysis in network countries.

One of the ways in which the Network sought to meet these goals was through a Competitive Grants Program. Individuals and teams from the six Network countries were eligible to compete for grants of roughly $15,000, to support research on topics of priority to their countries and to the region as a whole. Three separate rounds of competition were held in 2000, 2001, and 2002. A total of 31 grants were awarded, 5 to Ethiopia, 8 to Kenya, 6 to Malawi, 1 to Mozambique, 2 to Tanzania, and 9 to Uganda. A total of 81 researchers received support through the program. Roughly 55 percent were university based researchers, another 16 percent were from government ministries, 14 percent were from autonomous or semi-autonomous institutes or think tanks, and the remainder were from regional or international organizations, or the private sector.

The grants program was designed to strengthen local research capacity while fostering a sense of local ownership over both research priorities and results. The challenge was to combine these capacity building and local ownership values with peer-reviewed quality control. Numbers of research awards and final output volume were both constrained and limited under the peer-review requirement, but quality control was maintained, local ownership was protected, and significant local capacity was built. Research results moved successfully into use by local policy makers.

Research projects were screened for quality at three different points in the process. First, draft proposals from researchers were subjected to multiple written reviews by Network country teams. Second, revised proposals were screened by an independent Proposal Evaluation Committee (PEC). The five members of this committee included both Africans and outsiders from academia, the donor community, the CGIAR system, the private sector, and private foundations. The Network's Regional Advisory Committee (RAC) approved for funding only those projects recommended for support by the PEC. Third, research results that emerged from each funded project were submitted in draft form to the Network Coordinator and underwent a final blind peer review by outside evaluators. The Coordinator often imposed significant revision requirements upon authors prior to any publication of the results. Final results were published in the form of Network Reports and policy briefs, and posted on the Network website.

In 2003, an independent external evaluator found that the competitive grants program had built local capacity by providing applicants with technical and substantive support at both the proposal writing and the data analysis stage. At the proposal writing stage (early in each calendar year) potential applicants were eligible to attend two-day workshops on Proposal Writing for Policy Research, offered in the separate countries of the region by IFPRI's Training and Capacity Strengthening Program in partnership with national collaborators. At national Peer Review Workshops, the authors of draft proposals received multiple written reviews plus direct critique from country team members and visiting IFPRI staff. Though this process of critique discouraged some applicants, in 2002, for instance, a total of 36 out of the 44 proposals considered at these workshops were subsequently revised and submitted for external evaluation by the PEC. To support successful data collection, IFPRI's Training and

Capacity Strengthening Program also provided assistance in questionnaire design and support in methodology choices, bibliographic materials, and communications skills.

This book contains results of a select group of the completed projects. Given the commitment to honor priorities emerging from country teams, the range of topics covered is necessarily wide. Any losses due to lack of focus are more than offset by gains in insights on so many issues of fundamental importance to food and agricultural policy in eastern Africa. On behalf of the Network's Regional Advisory Committee, I express my sincere congratulations to all of the contributors for their skill and determination in completing their projects. The successful outcome of the Network's efforts is a result of unstinting contributions of many individuals. It is not possible to name all of them, but a few deserve mention. I commend IFPRI, particularly its former Director General, Per Pinstrup-Andersen, its current Director General, Joachim von Braun, the Chief of Staff in Director General's Office, Rajul Pandya-Lorch, and IFPRI Network Coordinator, Steven Were Omamo for establishing this network and providing the necessary technical and logistical support. And I thank the governments of Denmark, Norway, and Germany for providing the generous financial contributions that made the Network possible.

Finally, let me express the RAC's delight over plans for the Network's future. During the life of the Network, a strong partnership has been built up with the Eastern and Central Africa Program for Agricultural Policy Analysis (ECAPAPA) of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). When the Network was launched in 1998, IFPRI indicated that it would manage the Network for a period of 5 years. Thereafter, responsibility would be handed over to ECAPAPA. We are pleased to note that this plan is being honored. IFPRI and ECAPAPA have agreed to create a new regional collaborative research program, the ECAPAPA-IFPRI Food Policy Research Program. The new program will be housed by ECAPAPA, base its activities on themes of joint priority to the region, ECAPAPA, and IFPRI, build on the structures and processes developed by the IFPRI Network, and incorporate strong links to IFPRI's research divisions. The initial investment in the Network has yielded a very rich harvest indeed!

Harris Mule
Chairman, Regional Advisory Committee
IFPRI Eastern Africa Food Policy Network

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The editors thank all the chapter authors for their patience and perseverance in writing and revising their contributions. This book would not have come to fruition without their efforts. The studies whose results are reported here were completed under the Competitive Grants Program of the Eastern Africa Food Policy Network of the International Food Policy Research Institute (IFPRI). Funds for the Program were provided by the Danish International Development Agency (DANIDA), the German Federal Ministry for Economic Cooperation and Development (BMZ), and the Norwegian Agency for Development Cooperation (NORAD). IFPRI and its partners in eastern Africa gratefully acknowledge this support. Nick Vink, Stephen Mbogoh, Simeon Ehui, Finn Tarp, and Benno Ndulu served as a superb Proposal Evaluation Committee for the Network's Competitive Grants Program. Several scholars from both within and outside eastern Africa provided valuable reviews of study proposals and reports. Harris Mule, the Chairman of the Network's Regional Advisory Committee, Peter Hazell, the Director of IFPRI's Development Strategy and Governance Division, and Joachim von Braun, IFPRI's Director General, provided constant encouragement and advice.

INTRODUCTION

Steven Were Omamo, Suresh Babu, and Andrew Temu

Introduction

This book is one of the principal outputs of the IFPRI Eastern Africa Food Policy Network. The Network, known then as the IFPRI 2020 Vision Network for Eastern Africa, was launched in 1998, in response to requests by several eastern African countries for assistance in generating policy-relevant information. Covering Kenya, Malawi, Mozambique, Tanzania, and Uganda, the Network engages in a range of activities in policy research, capacity strengthening, and outreach (policy communication), with a view to contributing to efforts to reduce poverty, improve food and nutrition security, increase agricultural productivity, and promote sustainable use of natural resources in the region. Beginning in 2000, the Network supported several research projects under its Competitive Grants Program. A total of 30 projects were supported across all 6 Network countries. This book summarizes the outputs of 11 of the best projects.[1]

In selecting a title for the book, we drew on results of a stakeholder consultation undertaken in 2003-04 aiming to identify priorities for food and agricultural policy research in eastern Africa.[2] The consultation revealed that two issues dominated all others: (1) the future of smallholder agriculture, and (2) the roles of states, markets, and civil society in agricultural development. The book's 11 chapters therefore address several topics central to the future of smallholder agriculture in eastern Africa, ranging from analysis of farm-level productivity, to examination of community-level social capital, to modeling of economy-wide impacts of agricultural market liberalization. The result is a rich picture of conditions in eastern Africa's agri-food sector based on research undertaken by local researchers on high-priority issues for their countries. This book will help fill important knowledge gaps in a region where relevant and reliable information for food and agricultural policy making is often lacking.

The book's target audience comprises individuals and organizations charged with making and shaping food and agricultural policy in eastern Africa. That group includes national agricultural and overall economic policy makers and the senior technocrats who advise and support them. Also targeted are senior decision makers in international development agencies, donor countries, and private and civil society organizations. Members of the academic community interested in agricultural development in Africa are likely to find use and value in the book.

Agricultural Productivity, Natural Resource Management, and Food Security

The first three chapters address the interlinked issues of how to spur agricultural productivity growth, improve natural resource management, and increase food security. In Chapter 1, Rosetti Nabbumba and Godfrey Bahiigwa analyze the productivity and profitability of improved crop and livestock production technologies available to smallholders in Uganda. They find that under a range of conditions, these improved technologies outperform those in use by most smallholders in the country. These findings have important implications for

[1] A listing of all projects supported is provided in the Appendix.

[2] Omamo, S. W. and K. Nyombi. 2004. "Strategic Priorities for IFPRI in Eastern and Central Africa: Insights from an Electronic Stakeholder Consultation." Unpublished manuscript. Washington DC: International Food Policy Research Institute.

implementation of Uganda's ambitious Plan for Modernization of Agriculture (PMA), which aims to develop a sustainable commercialized agricultural sector. For the PMA to bear expected fruit, special effort is required to overcome the set of physical and institutional constraints that militate against wider adoption of improved technologies such as those considered here. Absent such efforts—many of which are likely to occur outside markets—the envisioned transformation of Ugandan smallholder farmers from conservative subsistence-oriented farmers into entrepreneurial market-oriented ones is unlikely to occur.

In Chapter 2, Beatrice Okello and Rita Laker-Ojok examine conditions in Uganda's wetland areas using the concept of the "critical triangle" of development objectives: economic growth, poverty alleviation, and environmental sustainability. At issue in the study are the determinants of wetland diversity, agricultural productivity, and food security in wetlands where thousands of smallholders eke out meager livelihoods. Wetland diversity is found to depend on location, prevalence of irrigated agriculture in cultivation, ease of access to swampland, and economic returns to wetland-based activities (e.g., hunting, fuelwood collection, and grazing). Agricultural productivity is found to be driven by rainfall seasonality, use of improved inputs and cultural practices, and farm size. Food security is significantly affected by value of fish products, farm size, nonfarm income, irrigation investments, and access to productive labor. The central recognition is that each of these factors is either scarce or lacking altogether for smallholders. Achieving "win-win-win" critical-triangle outcomes therefore hinges on success in improving access and availability of key resources and information to smallholders.

In Chapter 3, Paul Obunde, Cyrus Mbogo, Willis Oluoch-Kosura, and Agnes Kamoni explore linkages among land tenure, agricultural productivity, and natural resource management in Kenya. The main factors found to influence agricultural productivity are farmers' education, tenure security, land characteristics (e.g., slope), farm size, and use of improved inputs. Significant linkages are established between land tenure security (i.e. ownership of land title deeds) and investment in agroforestry practices that conserve land. Significant linkages are also established between natural resource depletion and investment in resource conservation practices. Again, a central recognition must be that most smallholders in Kenya lack access to those items that would lead to a virtuous cycle of productivity growth and resource conservation—i.e., they are typically poorly educated, they typically make limited use of improved inputs, and they typically hold no land title deeds.

Agricultural Markets and Marketing

Productivity growth without improvements in market functioning is counter-productive. The next four chapters examine conditions in some of the region's agricultural markets. In Chapter 4, Stephen Karingi and Hezron Nyangito use a computable general equilibrium model of Kenya's economy to quantify the impacts of trade liberalization on the country's agricultural sector. The motivation for this investigation is the enduring uncertainty and controversy surrounding the effects of trade liberalization on Kenya's economic backbone. The results indicate that trade policies affect Kenyan agriculture through several channels: changes in output levels, employment (and thus earnings) levels and distributions, exports, and investment. Overall, freer trade means more agricultural output but only marginally so, with similarly marginal gains in incomes. Kenyan agriculture, dominated as it is by smallholders with limited access to domestic markets let alone international ones, would appear to be inadequately prepared to realize full gains from trade.

In Chapter 5, Joseph Karugia, Stephen Wambugu, and Willis Oluoch-Kosura consider the role of infrastructure and government policies in determining the efficiency of maize marketing in Kenya following maize market liberalization. The central motivation for the analysis is the continuation of periodic food shortages in a liberalized market—i.e., contrary to many of the arguments used to justify market liberalization. The study finds that liberalization has enhanced market integration and improved information flows between market centers. Potential arbitrage opportunities exist between surplus and deficit areas, but major physical, institutional, and policy constraints prevent exploitation of these opportunities. Such constraints raise trading costs, erect barriers to entry and expansion in maize trade, and destabilize the overall trading environment. Given the prominence of maize as a production and consumption item for poor Kenyan smalholders, these findings highlight the nature of the enormous hurdles these households face in raising productivity either through expanded maize production with a view to selling surpluses, or though reduced maize production with a view to shifting to other crops and meeting maize consumption needs on market. High marketing costs render realized selling prices too low and buying prices too high.

In Chapter 6, Mulat Demeke and Tadele Ferede study the competitiveness and efficiency of grain marketing in Addis Ababa, Ethiopia by analyzing the roles of grain brokers, sellers, and buyers in the process of price discovery in the city's central market. Insights into the structure, conduct, and performance of the market emerge, along with deeper understanding of public and private institutions in defining levels and incidences of transaction costs. In general, the performance of the market has been characterized by high risk, limited access to credit, low margins, and low investment in marketing facilities. Policy implications center on the public sector's role in modernizing the market through: legal and regulatory mechanisms that strengthen contract enforcement; creation of a transparent system of grades and standards; and support for creation and functioning of trader and broker associations. These findings and recommendations emerge from a study of a specific urban market, but they have general applicability and relevance for agricultural marketing in eastern Africa's smallholder-dominated agricultural sectors.

In Chapter 7, Abebe Gabriel and Bekele Hundie trace linkages among farmers' perceptions of risk, post-harvest grain management practices, and household food security in Ethiopia. Farmers' expectations of high post-harvest grain losses are often borne out in reality, pointing to significant constraints on risk mitigation. Especially debilitating are liquidity constraints due to non-existent or poorly-functioning credit markets, along with limited options for diversification in production. Product markets characterized by high costs due to a range of physical and institutional constraints accentuate farmers' limited scope for maneuver, even as losses appear season after season. First-order constraints would appear to be in trade finance. Again, these findings resonate in smallholder areas across the region.

Private Provision of Public Goods

Weak and poorly managed public sectors suggest that private provision of public goods may become increasingly important in the future. Two studies provide useful insight into the range of impediments facing such provision in smallholder-dominated areas. In Chapter 8, Dick Sserunkuuma, Nicholas Ochom, and Herbert Ainembabaazi examine the extent and determinants of small-scale farmer participation in collective management of irrigation water for rice production in eastern Uganda. Existing regulations and incentives for participation in collective action are also examined. Results indicate that poor awareness of irrigation fee payment rules, poor enforcement of the rules, and perceptions among farmers that the cost of involvement in the scheme is higher than the benefits diminish compliance. Compliance is found to be higher: the higher the share of rice income in overall household income; the greater the diversity of rice plots owned; if a household is male-headed; if a household member has participated in training on soil and water conservation; the more diverse a household's output mix; the greater a household's access to credit; the higher a household's dependency ratio; and the greater the value of a household's asset holdings. Compliance is negatively associated with land tenure security, the number of rice plots held by a farmer, experience in rice farming, and perceptions that cost of participation exceeded the benefits.

In Chapter 9, Emmanuel Kaunda, D. Maliro, M. Mphepo, S. Khaila, I. Kamanga, L. Phiri, and J. Valeta examine factors lying behind the decline of an important fishery in Malawi. Failure to enforce management regulations, high entry into fishing, high fish prices, destruction of breeding areas, siltation, poverty, and weather-related factors all appear to play a part in the decline. Efforts to control over-fishing by clarifying property rights are viewed as necessary but not sufficient to reverse recent trends. Additional roles for policy are identified in strengthening local institutions and encouraging growth of alternative income generating activities for local communities.

Marginal Areas

Large numbers of eastern Africa's smallholders reside in areas considered marginal for cropping. Livestock are key components of livelihood systems, as are mutual assistance arrangements of various kinds. The final two chapters explore these issues. In Chapter 10, Lawrence Mugunieri, John Omiti, and Patrick Irungu examine the nature, characteristics, and activities of community-based animal health workers (CBAHWs) in Kenya's marginal areas, and their influence on livestock productivity. These CBAHWs constitute an institutional innovation in animal health management under conditions in which public provision of services outside markets is being replaced by private provision in increasingly liberalized markets, with local communities exerting increasing influence on market outcomes. CBAHWs are found to fill an important gap in animal health care systems. They typically focus on delivering curative services, mostly to resource-poor smallholders who fall outside formal (i.e., veterinary doctor-based) animal health delivery systems. Such bifurcation in delivery systems to cater for demands of different farmer types is clearly efficient. But it raises a new set of challenges. Most importantly, the sustainability of CBAHWs is unclear. Continual professional development, including explicit linkages with and support from veterinary doctors, is crucial.

In Chapter 11, Samuel Mwakubo, Gideon Obare, John Omiti, and Lutta Mohamed explore the influences of social capital on agriculture in Kenya's arid and semi-arid areas. The density and diversity of membership in mutual assistance groups of various kinds, the degree of participation in decision making, and the norms and values that prevail in a community are elements of social capital found to influence soil conservation efforts, albeit in different directions. Of crucial importance is the finding that prevailing norms and values impact negatively on productivity. Given the context-specificity of social capital, the generalizability of this result is not clear. However, the result certainly points to the depth of institutional change likely to be required in smallholder areas if, as in this case, natural resource management is to be sustainably improved.

Conclusions: Roles of States, Markets, and Civil Society

Viewed together, this eclectic collection of studies demonstrates that the future of smallholder agriculture in eastern Africa will turn on how well countries address a range of problems and opportunities specific to smallholders. The future of smallholder agriculture in the region is therefore highly uncertain and contingent on many policy-related factors.

The region's smallholder agricultural systems are intrinsically both highly clustered at local levels and highly dispersed spatially and institutionally. Pressures on these systems are intense. Rural populations continue to expand, resources become more scarce, and productivity stagnate, even as the quality and coverage of key rural services erode. The studies suggest that the challenge for states lies in finding ways to substantially increase investments in such basic areas roads, telecommunications, research, and extension, and, equally importantly, in providing the kind of stability (and avoiding the kind of instability) that only states can provide (or create). In markets, the goal must be greater efficiency and enhanced competition, and, in most cases, organized articulations of supply and demand. In civil society, the target must be to fill gaps left by public sectors lacking capacity in key areas, and by markets that are likely to be inherently imperfectly competitive.

The studies confirm that there are no easy answers. For there would appear to be no "natural" processes at work moving smallholder agricultural production and trade toward paths featuring sustainable growth and poverty reduction. Such paths must be carved out of territory that is at once difficult, ambiguous, and devoid of reliable maps and guidelines. The studies make available a fresh body of information that should prove relevant and useful in efforts to develop and utilize such maps.

Part One - Agricultural Productivity, Natural Resource Management and Food Security

CHAPTER ONE

Agricultural Productivity Constraints in Uganda

Rosetti Nabbumba and Godfrey Bahiigwa

Agricultural Productivity Constraints in Uganda

I. Introduction

The Government of Uganda (GOU) has a comprehensive development strategy called the Poverty Eradication Action Plan (PEAP)/Poverty Reduction Strategy Paper (PRSP). It aims at shifting substantial budgetary resources towards poverty-sensitive areas while remaining within the overall resource envelope and the macroeconomic targets that were set in the medium-term expenditure framework (MTEF). PEAP has four pillars: achieving sustainable economic growth and structural transformation; ensuring good governance and security; increasing the ability of the poor to raise their incomes; and, improving the quality of life for the poor.

The Plan for the Modernization of Agriculture (PMA) (MFPED and MAAIF 2000) was designed to operationalise the PEAP via increasing the ability of the poor to raise their incomes. This is through the transformation of the agricultural sector from being largely subsistence farming to a commercially oriented one. The policy objectives are: increase incomes and improve the quality of life for poor subsistence farmers, improve household food security, provide gainful employment, and promote sustainable use and management of natural resources.

It is widely believed that successful implementation of PMA will most certainly come from technological progress brought about by the introduction of new technologies that will increase productivity and profitability. Uganda, like many other developing countries in sub-Saharan Africa, is continuing to record very low levels of farm productivity. Available evidence shows that farm-level yields are several times lower than those at agricultural research stations for similar crops. Farmers achieve between 13% and 33% of the yields attainable at research stations (MAAIF 1996). This study finds similar results, with crop yields in the range of 13%-49% of the yields at research stations. This study demonstrates that there have not been significant changes in crop yields in almost a decade as table 1 shows.

Table 1: Yields of selected crops in Uganda, 1993 and 2001

	Farm level (FL1)[1]	Farm level (FL2)[2]	Research	FL1 as a	FL2 as a
Crop	**1993**	**2001**	**Station (RS)**	**% of RS**	**% of RS**
Beans	1.0	0.66	3	33	22
Maize	1.8	1.23	8	23	15
Finger millet	1.6	0.67	5	32	13
Cassava	9.0	10.98	50	18	22
Sweet potatoes	4.0	8.47	30	13	28
Irish potatoes	7.0	10.56	35	20	30
Bananas	5.9	17.26	35	17	49

Source: Kawanda Agricultural Research Institute (KARI), 1993 and Survey 2001

Such a state of agricultural sector performance raises serious policy questions that have implications for focusing on the agricultural sector as the avenue for raising rural incomes and reducing poverty. What constrains farmers from achieving higher levels of productivity? Could

[1] Based on farm survey by KARI of NARO in 1993

[2] Based on farm survey for this study in 2001

there be specific farm level factors that hinder technology adoption? Do the constraints vary across districts and agro-ecological zones? One of the implicit assumptions that the PMA makes is that if technologies are developed and disseminated, farmers will adopt them and increase farm productivity. It is assumed that at current prices, the technologies that are available are profitable. In fact, there are several improved technologies on the market, and yet the adoption rate by farmers is very low. It has not been clearly established whether the low adoption rate is due to poor technology dissemination or low product prices that make it unprofitable for farmers to adopt the technologies.

This report presents findings of a research effort that was intended to offer some answers to questions raised above. It examines the profitability and productivity of two available technologies—improved maize seed and improved cattle breed—in four districts in Uganda. The profitability of these improved technologies is compared to those of unimproved maize and indigenous cattle, in that order. A similar comparison is made for the measures of productivity—maize yield and milk yield.

The PMA correctly recognizes the location-specific nature of poverty and the constraints to agricultural production and productivity. Decentralization is central to the country's chosen mode of governance with responsibility for service delivery devolved to the local governments (districts and sub-counties). However, there is little or no empirical research, specific to a district or sub-county, which is available to these local governments that articulate productivity constraints. For example, maize is grown throughout the country, but the constraints to increased maize productivity may vary from one district to another and therefore policy responses and investment decisions will vary accordingly.

Study objectives

On the basis of the foregoing discussion, this study set out to assess district differences in agricultural productivity and profitability and to analyze the constraints to increased productivity in agriculture with the ultimate aim of proposing policy strategies for appropriate investment.
The research process was guided by three key objectives:

- Determining agricultural productivity levels and constraints for several districts, with a focus on maize and cattle.
- Assessing profitability of two available technologies (improved maize and improved cattle breed).
- Suggesting policy strategies to improve agricultural productivity.

The following four hypotheses were tested:

- Growing improved maize seed is not profitable to farmers at current market prices.
- Rearing improved cattle is not profitable at current market prices.
- Agricultural productivity levels in Uganda vary across districts due to technological differences
- Factors constraining agricultural productivity are location-specific.

II. Measuring Productivity and Profitability

Raising agricultural productivity has long been on Uganda's development agenda, although progress has been slow. The modest increases in agricultural production during the 1990s largely came about from expansion of cultivated land rather than improvements in unit area productivity (World Bank 2001). We can draw on a range of schools of thought on how best to increase agricultural productivity, especially in a developing country. Thirwall (1983) observes that the quickest and cheapest way to raise productivity will depend on the reasons for low productivity and the constraints to agricultural growth. These vary from country to country and from region to region. He notes that in some cases, it is an inappropriate labor-to-land ratio combined with a lack of complementary inputs. In other cases, it is the structure and organization of agriculture; and, in many cases, it is a combination of both coupled with unfavorable natural factors. He concludes by laying emphasis on policies to raise the level of farm productivity as the most urgent development priority.

Kalirajan *et al* (1996) complement this line of argument by pointing out that as long as farmers are not operating on their frontiers due to various non-price and organizational factors, which is very likely in the case of Uganda, technical progress cannot be the only source of total factor productivity growth. A substantial increase in productivity under these circumstances can still be realized by improving the method of application of the given technology. It is important to know whether technological progress is stagnant over time and whether the given technology has been used in such a way as to realize its full potential. Certainly, the yield results in Table 1 show that Uganda farmers are operating below their frontiers and, therefore, available technologies are not being used to their full potential.

The approaches to productivity measurement in literature range from the Cobb-Douglas functions, linear programming, indexes based on the Translog Transformation Function, the Divisia index, Laspeyres quantity index and many other econometric transformations based on modern production theory. The choice of method to use has generally depended on the nature of problem being addressed and the available database. Most of the productivity measurements have concentrated on macro-level analysis, as most data is available in the aggregated form. Savadogo *et al* (1994) argue that such aggregate studies are limited to only a few composite product categories because of lack of more detailed data on labor, land and capital allocations to crops. Comparatively, microanalysis tends to track smaller samples over shorter periods but digs below the aggregate surface to discern and explain productivity differences over crops, zones and farmer groups. Due to data constraints, here productivity is simply taken as the yield of maize (metric tons per hectare) and milk (liters per lactating animal).

While Africa is the only developing region where crop output and yield growth is lagging seriously behind population growth, there is very scanty literature on measurement of productivity in this region due to lack of reliable data. Savadogo *et al* (1994) show that, since the spate of African farm management studies in the 1960s and 1970s, soils have rapidly degraded, access to land has become increasingly constrained, and factor and credit markets have changed structurally. These changes should affect productivity across farm types, suggesting the need to revive the attention to farm-level analysis. Given the emphasis that Uganda is putting on agriculture, such analyses are important not only for improving rural livelihoods, but also for general economic growth and poverty reduction.

III. Data Collection

A cross-sectional, stratified sampling design was used in this study. Four sample districts—Iganga, Hoima, Lira and Apac—were purposively selected to broadly represent two different regions and two different agro-ecological zones within the country. The choice of districts was based on three criteria: agro-ecological zoning; geographical location; and population density as a crude indicator of land productivity[3]. Two major farming systems were investigated in this study: the Banana/Coffee Farming System and the Northern Farming System. For comparison purposes, it was found necessary to select at least two districts from the same agro-ecological zone.

Iganga, located in the eastern region, falls within the Banana-Coffee Farming System while Hoima, also in the same farming system, is in the western region. Both Lira and Apac are in the northern region and fall within the Northern Farming System. Two districts were purposively selected from Northern Uganda because it is the largest region in the country—it covers 35% of the total land surface. Since PMA has been conceived as one of the major interventions for reducing poverty, we thought that it was important to focus on districts in a region that has experienced increasing poverty at a time when livelihoods were improving elsewhere in the country[4].

Because of the differences in soil types and rainfall patterns, there are major variations in the cropping characteristics within the two farming systems. Farmers in the Banana-Coffee System, characterized by fertile soils and more reliable annual average rainfall of over 1000 mm, are able to grow a variety like robusta coffee, banana, maize, and root crops and horticultural crops. Livestock production also plays an important role in farmers' livelihoods. Those in the Northern System are faced with a low annual average rainfall of 500 mm-1000 mm. hence; farmers tend to grow drought-resistant crops like simsim, finger millet, sorghum and sunflower. Cotton and tobacco also do well in the region while livestock is important as well.

Forty households were interviewed in each of the two sub-counties that were selected from each district. This made up a total of 320 respondents for the study. Respondents were purposively selected across scale (small and medium) but randomly within scale. Agricultural extension workers and local government officials facilitated identification of farmers' lists from which we sampled. In order to get a quick understanding of the farming systems, participatory rural appraisal techniques—such as focus-group discussions and key-informant discussions—were held with extension workers at the sub-county and district level, input suppliers, and produce buyers.

In the assessment of productivity and productivity levels and constraints, maize and cattle were the enterprises selected. Maize was chosen because it is grown in almost all districts, it is important in terms of food security, and it is a growing source of foreign exchange through exports. Cattle are also found in all districts, though with varying scales and degree of importance. They are a store of wealth or savings, a source of household income, an important contributor to household nutrition, and an important source of manure that rejuvenates soil productivity, especially when integrated with crop production.

While it would have been more informative to collect data for two cropping seasons representing a calendar year, this was not done for one major reason. Experience shows that farmers have a short recall period beyond which answers given are more hypothetical rather than real. This

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[3] In Uganda, farming populations tend to inhabit first, those areas with very fertile land and as population grows, they migrate to areas that are less fertile. High population density is associated with high land productivity at the time of settlement.

[4] The 1999/2000 National Household Survey revealed that between 1997 and 2000, poverty in Northern Uganda increased from 60% to 65% (Appleton, 2001).

study, therefore, limited itself to the most recent complete cropping season (August 2000 to January 2001) to avoid this shortcoming. The household surveys were conducted between May and September 2001.

Data Analysis

A combination of analytical tools was used including descriptive statistics, measures of profitability and productivity, and simple regressions. The study set out to assess the profitability of improved technologies (maize and cattle) and to establish levels of agricultural productivity for both maize and cattle. In order to assess profitability, data were collected on quantity and prices of output, and variable inputs and fixed inputs for both maize and cattle. Profit is computed as total revenue less total costs (variable costs plus fixed costs). Computing fixed costs for farms with multiple enterprises presents a problem of apportioning fixed costs to individual enterprises. In this study, total fixed costs for crops were computed and divided by the number of the major crops grown by the household. This approach has the underlying assumption that fixed inputs are used uniformly across the different crops. Therefore, there is a potential of under- or over-estimation of fixed cost for an individual crop. A similar approach was used to compute fixed costs associated with cattle.

Maize profits Π_{mz} are given by

$$\Pi_{mz} = P_{mz} Q_{mz} - \sum_{i=1}^{n} P_{xi} X_i - FC_{mz}$$

where P_{mz} is the output price of maize, Q_{mz} is the quantity of maize produced, P_{xi} is the price of the i^{th} variable input, X_i is the quantity of variable input *i* used in the production of maize, and FC_{mz} is the fixed cost incurred in maize production.

Cattle profits Π_{ct} are given by

$$\Pi_{ct} = (P_{ct} Q_{ct} + P_{mk} Q_{mk}) - \sum_{j=1}^{m} P_{xj} X_j - FC_{ct}$$

where P_{ct} is the price of cattle, Q_{ct} is the number of cattle in herd, P_{mk} is the price of milk, Q_{mk} is the quantity of milk produced, P_{xj} is the price of the j^{th} variable input, X_j is the quantity of variable input *j* used in cattle rearing, and FC_{ct} is the fixed cost incurred in cattle rearing.

Maize profitability was compared in two main ways. First by controlling for technology (local versus improved maize), and second, by controlling for scale (land allocated to maize). For cattle, profitability was compared by controlling only for technology (type of cattle breed). Regression analysis was used to identify determinants of both maize and cattle profitability. Theoretically, the profit function is a function of output and input prices, and it should be non-decreasing in output prices and non-increasing in input prices (Varian 1992).

Maize productivity is simply measured as quantity produced per unit of land (tons per hectare), to be differentiated by improved and local maize varieties. Cattle productivity is similarly measured as milk produced per lactating animal (liters by animal) differentiated by improved and indigenous cattle breeds.

IV. Research Findings

To put the discussion into context, we begin with a brief description of the key characteristics of the sample. This is then followed by a more in-depth analysis of profitability, productivity and the key constraints faced in farming.

Sample Characteristics

The sample had 318 households, 95% male headed and only 5% female headed. Close to half the household heads (48%) had primary education, 25% secondary, 14% tertiary, 5% vocational and 8% did not attend school at all. The average farm size for the lowest 25% was 1.56 ha, while the highest 25% had an average farm size of 2.7 ha. Most of the land is used for crop farming (55%), livestock (20%), while unutilized (idle) land accounted for 25% of total farm size. Within the sample, 61% of the households planted improved maize seed, compared to 39% that planted local seed during the cropping season under study. Unlike the case of maize, 90% of households reared indigenous cattle; 3% crossbreed and 7% exotic (pure breed).

Land Utilization

The average farm size was 10 ha ranging between 11.9 ha in Apac and 2.7 ha in Iganga (Table 2). On average, 4 ha (40% of total land) were dedicated to livestock production as compared to 2.6 ha (26%) to crop farming. Hoima had the largest proportion of land allocated to livestock production (3.6 ha) and Iganga the least (0.4 ha). There was not much variation among districts with regard to the average land allocated to crop farming.

Table 2: Land use (ha) characteristics by district

District	Farm size (Ha)	Land for livestock (Ha)	Land for crops (Ha)	Unused land (Ha)	Average area for maize (Ha)
Apac	11.9	2.5	3.3	6.1	1.05
Hoima	11.6	3.6	2.5	5.5	0.59
Iganga	2.7	0.4	2.0	0.2	0.68
Lira	5.6	1.3	2.7	1.6	2.14
Sample Average	**10.0**	**4.0**	**2.6**	**3.3**	**1.18**

Source: Survey 2001

Apac and Hoima had substantial tracts of idle land. Leaving land under fallow and keeping it as a form of long-term investment were the two main reasons given for having unused land. It was only in a few cases (about 10%) where conflict over ownership arose as another reason for leaving land idle particularly in Apac district. Regarding land ownership, 88% of the sampled households indicated that land was owned by men (either household heads or male relatives), about 7% was co-ownership between husband and wife while the remaining 5% was land either owned by a woman (particularly female household heads), the clan or church. Hoima district had the smallest average area for maize production (0.59 ha) while Lira had the largest average area for maize (2.14 ha), almost four times that of Hoima.

Land allocation and yields of 12 crops by district are presented in Table 3. The table serves to illustrate the importance of maize all four districts. Cropland allocation to maize was highest in two districts (Hoima and Iganga) and second highest in the other two districts: Apac (maize was second to cotton) and Lira (maize was second to sunflower).

Table 3: Land allocation and yield by crop

	Area allocated (ha)				Yield (mt/ha)			
	Apac	Hoima	Iganga	Lira	Apac	Hoima	Iganga	Lira
Crop								
Maize	1.03	0.66	0.69	1.92	1.50	1.50	1.45	0.59
Beans	0.81	0.35	0.21	1.50	0.64	0.60	0.98	0.34
Cassava	0.82	0.45	0.49	0.87	7.49	5.81	4.36	4.90
Coffee	-	0.44	0.58	-	-	1.06	1.29	-
Millet	0.57	0.37	0.17	1.06	0.53	2.53	1.03	0.43
Cotton	1.44	-	0.34	1.37	0.65	-	1.16	0.12
Bananas	-	0.46	0.31	-	-	13.3	2.24	-
Groundnuts	0.69	0.39	0.22	0.71	2.67	1.80	0.32	0.32
Simsim	0.89	-	-	1.05	0.50	-	-	0.27
Sunflower	0.76	-	-	1.93	2.37	-	-	0.74
Sweet potatoes	-	0.46	0.32	-	-	4.09	8.92	3.90
Sorghum	-	-	-	1.28	-	-	-	0.37

Source: Survey 2001

Maize profitability and productivity

Marketing and farm incomes

More than half of maize produced on farm is marketed. The share of marketed output ranges from 59% in Iganga, located in eastern Uganda, to 63% in Lira, found in northern Uganda. These results are consistent with those found in the National Service Delivery Survey (MOPS 2001), which found that most farmers in Uganda sell less than 50% of their produce and this is done mainly at the farm gate. There is hardly any difference in the share of maize that is marketed by households in all four districts (Table 4). Yields are similar in all districts, except in Lira where maize yield is significantly lower than in the other three districts. As a result, the returns per hectare are lowest in Lira despite having the highest maize price per metric ton.

Table 4: Maize characteristics

District	Share of marketed production (%)	Price (Sh/Mt)	Returns per ha (Sh/Ha)	Yield (Mt/Ha)
Apac	61	148,910	250,508	1.50
Hoima	59	177,459	284,332	1.50
Iganga	59	165,066	241,469	1.45
Lira	63	206,890	124,052	0.59

Source: Survey 2001

There was no statistically significant difference in the average price and yield of maize in Hoima and Iganga, which are in the same agro-ecological zone. As a result, the returns per hectare were also not significantly different. Apac and Lira have significant differences in both the price and yield. As a result the returns per hectare are different and are lowest in Lira. Maize yield was lowest in Lira mainly due, perhaps, to pests and diseases that was reported in the previous season and during the past years (refers to Tables 12 and 13). Certainly, the differences were not due to maize technology because 77% and 79% of farmers planted improved maize in Apac and Lira, respectively.

Profitability of Maize

Maize profit was computed by subtracting total maize production costs from maize revenue. Total costs include variable costs (labor, seed, herbicides and fertilizers) and fixed costs (mainly farm implements such as hoes, ox-ploughs, axes, etc). Maize revenue is the product of the quantity of maize produced and the price. The difficulty faced in computing maize profits was apportioning fixed costs. For example, most households grow a multiple of crops using the same farm implements. It is difficult to share out the fixed costs across various crops. In this study, the fixed costs associated with crop production were simply divided by the number of major crops grown. This has the possibility of under- or over-estimating fixed costs for a particular crop, thereby over-or under-stating its profitability.

Table 5 presents overall maize profits per hectare by district, without differentiating between the types of maize planted. The results show great variability in maize profitability, with Lira having the lowest level of profitability and Hoima the highest. Even within the same agro-ecological zone, there are wide variations. Apac and Lira are in the same agro-ecological zone; however, it is about 50% more profitable to grow maize in Apac than in Lira. Hoima and Iganga are also in the same agro-ecological zone, but maize profitability in the former is about one-and-a-half times more than in the latter. However, the differences in maize profitability per hectare (without differentiation by maize variety) are not statistically significant, except between Lira and Hoima.

Table 5: Maize profits per hectare

Farming System	District	Sh/Ha
Northern	Apac	173,563
	Lira	108,336
Coffee Banana	Iganga	162,766
	Hoima	216,715

Source: Survey 2001

The key objective in assessing maize profitability was to determine whether or not it was profitable to grow improved maize seed compared to local or indigenous maize seed. Table 6 presents a comparison of maize profit per hectare, maize price, and maize yield for the entire sample, controlling for the type of maize seed planted. A test of the difference in averages shows that farmers who planted improved maize had an average profit that was statistically significantly higher than the average profit for farmers who planted the local maize variety.

Two more variables are compared: price of maize and yield. Results show that the difference in price between local and improved maize was not significant. Maize yield was significantly higher for improved maize than for local maize. These results clearly indicate that differences in maize profitability are due to the type of maize seed grown. Growing improved maize seed is more profitable than growing local maize. Table 6 also presents the three variables (profit, price and yield) compared by farming system for the entire sample. Except for yield, the results clearly indicate that maize profitability is not determined by where it is grown, and that there are no significant differences in the price received by farmers in the two farming systems (Northern and Coffee-Banana).

Table 6: Key economic variables for maize by variety and agro-ecological zone

	Improved maize (n=179)	Local maize (n=109)	T-test[5](mean difference) P-value
Maize Profit (Sh/Ha)	190,531	111,872	0.0555
Price (Sh/Mt)	176,139	173,009	0.5663
Yield (Mt/Ha)	1.37	1.00	0.0414
	Coffee-banana system (n=130)	Northern system (n=160)	
Maize Profit (Sh/Ha)	186,005	140,135	0.2499
Price (Sh/Mt)	170,625	178,625	0.1278
Yield (Mt/Ha)	1.47	1.04	0.0165

Maize profitability of local and improved varieties was also compared across the four districts. Improved maize was more profitable than local maize in all four districts in absolute terms, but statistically significant (5% level of significance) in only two districts (Hoima and Lira) as shown in Table 7.

Table 7: Maize profit per hectare by variety and district

District	Improved maize	Local maize	T-test (mean difference) P-value
Apac	201,083 (60)	81,829 (18)	0.383
Hoima	378,427 (22)	108,927 (33)	0.020
Iganga	184,427 (32)	147,703 (41)	0.395
Lira	120,200 (65)	62,980 (17)	0.024

Source: Survey 2001. Numbers in parentheses are the number of observations

Maize profitability of local and improved varieties was also compared, controlling for farm size. Again, improved maize was more profitable in absolute terms across the four farm size quartiles, and the differences in averages were statistically significant in the first, third and fourth quartiles (Table 8). These findings show planting improved maize is profitable for all farm sizes, implying that scale may not be important in explaining profitability of maize.

Table 8: Maize profit per hectare, by farm size

Quartile	Improved maize	Local Maize	T-test (mean difference) P-value
1	347,051 (46)	153,845 (62)	0.053
2	186,749 (42)	153,254 (24)	0.436
3	182,347 (43)	60,030 (9)	0.056
4	126,049 (48)	61,136 (14)	0.052

Source: Survey 2001. Numbers in parentheses are the number of observations

Regression results

Table 9 presents the results of regression analysis for maize profit as the dependent variable. All variables are in logarithms except number of extension visits and the dummy for type of maize

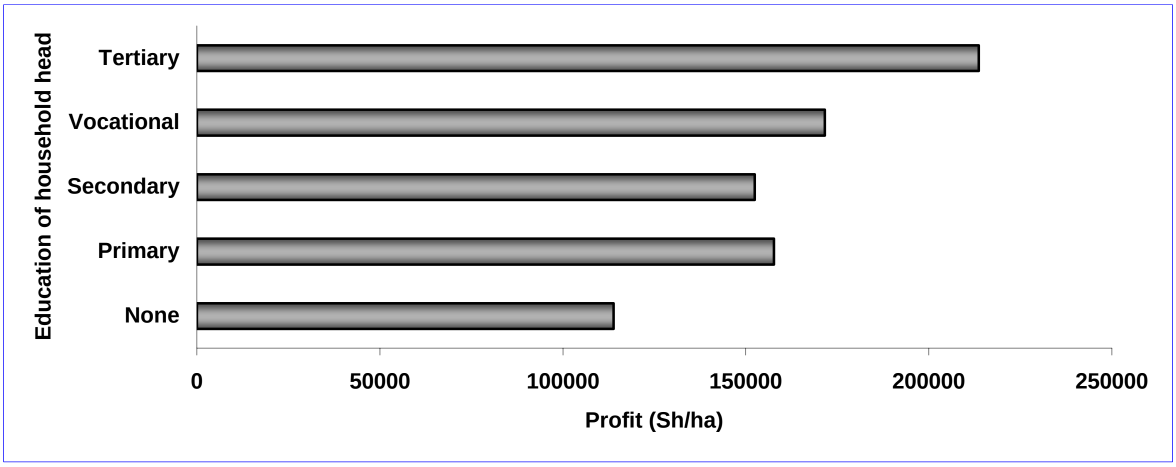
[5] This it a student t-test for the difference in means of improved maize seed and local maize seed that were grown by the household, but here only the p-values are presented.

seed planted. The results indicate that there are five main determinants of maize profitability. First, the amount of land allocated by a household to maize production is important, implying that access to land by a household is important. Second, extension advice (proxied by number of extension visits) also contributes to increased profitability, perhaps either through advice on what maize variety to plant, when to plant or other agronomic information such as spacing that is important to realizing higher yields. Third, the price of maize is very important, the higher it is, the higher will be the profits. Whereas this is obvious and conforms to theory, it points to the importance of markets and market information. Farmers can only derive full benefits of investing in improved technology if the prices are high enough to warrant the investment. Fourth, the type of maize seed is important. Planting improved maize seed increases profitability. Indeed this is consistent with results presented in Tables 6, 7 and 8, that improved maize is more profitable than local maize. Fifth, education level of the household head is important. The higher the number of years spent at school, the higher the level of profits realized from growing maize. This is perhaps related to the ability to appreciate and take up improved technology. As figure 1 show, farmers with no education had the lowest level of profits per hectare, and those with tertiary education had the highest level of profits per hectare.

Table 9: Determinants of maize profitability (dependent variable: maize profits)

Variable	Coefficient	T-statistic	P-value
Maize area	0.71	8.42	0.000
Number of extension visits	0.14	2.84	0.005
Price of maize	1.15	4.05	0.000
Maize variety dummy (1=improved, else 0)	0.35	2.10	0.036
Years of schooling of household head	0.53	2.11	0.036
Intercept	-3.96	-1.44	0.256
$R^{-2} = 0.374$			
N = 230			

Figure 1: **Maize profitability and education of household head**



Maize productivity

Maize productivity is simply measured as output per unit of land. Across all four districts, improved maize had a higher level of productivity (measured as metric tons per hectare) than local seed in absolute terms and the differences were statistically significant for two districts—Hoima and Lira (Table 10). This implies that farmers that have not adopted planting improved maize seed are doing so for reasons other than non-profitability of improved maize varieties.

These findings from the statistical and regression analyses are significant in several ways. First, growing improved maize is more profitable than growing local maize seed. Even though there is no significant difference in the output price for both varieties, the higher productivity (yield) of improved maize seed ensures higher returns for farmers growing improved seed. These findings give impetus to the need to promote productivity-enhancing technologies through the National Agricultural Advisory Services (NAADS) that is responsible for dissemination of agricultural technologies to farmers. At the same time, the results also render support to research efforts, especially by Uganda's National Agricultural Research Organization (NARO) in developing high yielding maize varieties.

Table 10: Maize yield by district and type of maize seed planted

District	Improved maize	Local Maize	T-test (mean difference) P-value
Apac	1.67 (60)	0.95 (18)	0.242
Hoima	2.34 (22)	0.93 (33)	0.000
Iganga	1.61 (32)	1.43 (41)	0.268
Lira	0.66 (65)	0.36 (17)	0.024

Source: Survey 2001. Numbers in parentheses are the number of observations

Second, the results indicate the potential for PMA to make a difference in northern Uganda, especially in rural areas where poverty rose between 1997 and 2000 from 62% to 67% (Appleton 2001). The fact that poverty fell in the rest of the country among producers of food crops implies that promoting food crop production, especially maize in northern Uganda has the potential to reduce poverty in that region.

Third, the results dispel the widely held view that the Northern Farming System is less productive than the Banana-Coffee System because of less rainfall in the former region and having one main planting season. Therefore, promoting improved maize production in the northern region is one way of reducing rural poverty. In fact, the survey results indicate that 78% of sampled farmers in the Northern Farming System planted improved maize seed, compared to 41% in the Coffee-Banana System. This improved technology that has high returns should be promoted in all districts of northern Uganda in the fight against poverty. The persistence of poverty in the north is not due to non-productivity of the region, but perhaps due to the war that has affected that area since the late 1980s.

Fourth, extension is important in promoting productivity and profitability, and therefore NAADS has to ensure that it reaches farmers with the right information to enable them to improve their farming. NAADS is mandated to provide market information to farmers, which is something important as it determines profitability and influences resource allocation by households.

Fifth, farmer education is important. Therefore, the agricultural education intervention in PMA should be fully operationalized. Of particular importance is the adult education component, which will benefit farmers with no level of education and whose profitability is lowest. The introduction of agriculture as a subject in all schools would contribute to increased productivity in the long-term.

And sixth, the results show that the more land dedicated to maize production, the higher the profits. This follows the national trend in crop production, in that increase in production and profit has mainly been through expansion of land rather than improved productivity of land. Given the increasing scarcity of land in Uganda, particularly among the poor[6], future increases and productivity are unlikely to come from expansion in crop acreage or pastureland, but rather from increases in land and pasture productivity through adoption on improved technologies.

Maize productivity constraints

Since most of the government programs are now implemented in a decentralized framework, whereby local governments have autonomy over their budgets, it is imperative that districts are aware of the major constraints to farming so as to provide for them in their planning and budgeting processes. In addition to measuring profitability and productivity, this study analyzed factors, from the farmers' perspective, that constrain agricultural production. The hypothesis behind the analysis was that agricultural productivity constraints are location-specific hence requiring location-tailored interventions.

In order to get a deeper understanding of the major factors constraining crop production, the study analyzed the priority constraints at two levels: constraints to maize production generally over the years and then focusing on the priority problems experienced during the previous season. While some constraints appear to be season specific, on the whole, the problems that are faced by farmers are consistently similar across the years. However, there are variations in the constraints faced by farmers in the specific districts as discussed further in the proceeding sections.

Crosscutting constraints

The main constraints to increased maize production across the four districts during the season under study (August 2000-January 2001) were pests and diseases, followed by inadequate capital to invest in production, and low and fluctuating prices. When asked to rank the priority constraints to maize production generally over the years, farmers still brought up these constraints, although in a slightly different order. Pests and diseases still ranked as the number one problem, closely followed by low and fluctuating prices, and inadequate capital (Table 11), in that order.

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[6] MFPED/UPPAP, 2003. The 2nd Participatory Poverty Assessment Report. Depeening the Understanding of Poverty, Kampala.

Table 11: Crosscutting priority constraints to maize production

Constraint	Percentage response (%) Previous season	Generally over years
Bad roads	0.39	0.94
Drought	7.16	5.80
Expensive labor	0.87	0.00
High input costs	2.90	3.37
Inadequate capital	9.57[2]	10.48[3]
Inadequate labor	6.77	3.84
Inadequate land holding	0.77	2.25
Inadequate market	6.67	8.33
Lack of inputs	4.35	4.77
Lack of extension services	0.48	0.94
Lack of good means of transport	2.13	4.30
Low price and price fluctuation	8.22[3]	13.19[2]
Low soil fertility	0.97	2.15
Low yields	1.64	1.50
Pests and diseases	23.02[1]	15.25[1]
Poor storage	6.87	5.43
Theft	1.06	3.09
Unpredictable weather	2.80	3.09
Weeds	3.97	2.15
Wild animals/birds	7.25	4.96
Other constraints	2.13	4.21
Total	100.00	100.00

Source: Survey 2001.

District-specific constraints

While pests and diseases still stood out as the most pressing problem for Apac, Iganga and Lira in the previous season; for Hoima, the most constraining factor to maize production was wild animals and birds (Table 12). The large unexploited forests in parts of Hoima that harbor the wild animals and birds that damage crops in the field probably explain this.

Table 12: Priority constraints to maize production for the previous season by district

Constraint	Percentage response (%)			
	Apac	Hoima	Iganga	Lira
Bad roads	1.13	0.00	0.00	0.00
Drought	6.50	0.45	**15.24**[2]	7.23
Expensive labor	1.13	2.26	0.00	0.00
High input costs	6.50	0.45	1.90	0.80
Inadequate capital	3.11	**14.93**[2]	**10.48**[3]	**13.25**[2]
Inadequate labor	6.50	**8.60**[4]	3.33	**8.43**[4]
Inadequate land holding	0.28	1.36	1.90	0.00
Inadequate market	**8.47**[4]	7.24	3.33	6.43
Lack of inputs	5.93	3.17	1.90	5.22
Lack of extension services	0.85	0.90	0.00	0.00
Lack of good means of transport	3.11	1.36	1.43	2.01
Low price and price fluctuation	**12.43**[2]	6.33	**10.00**[4]	2.41
Low soil fertility	0.28	1.36	2.86	0.00
Low yields	2.82	0.90	2.38	0.00
Pests and diseases	**19.21**[1]	**12.22**[3]	**29.52**[1]	**32.53**[1]
Poor storage	**10.17**[3]	3.62	1.90	**9.24**[3]
Theft	0.28	1.81	0.48	2.01
Unpredictable weather	1.69	2.26	3.33	4.42
Weeds	8.19	1.36	3.81	0.40
Wild animals/birds	0.85	**27.60**[1]	1.90	2.81
Other constraints	0.56	1.81	4.29	2.81
Total	100.00	100.00	100.00	100.00

Source: Survey 2001. Note: The four priority constraints in each district are highlighted in bold and ranked, 1 as the most constraining factor

In northern Uganda, a low and fluctuating price was the second most pressing constraint in Apac while it seemed not to be an issue in neighboring Lira. This has already been confirmed by the relatively higher prices received by farmers in Lira as compared to Apac (Table 4). Instead, inadequate capital was the second most important constraint in Lira. Poor storage conditions, unique to these two districts, were ranked as the third priority constraint. Inadequate market for farm produce was a priority constraint in Apac but not Lira where the fourth most pressing problem was inadequate labor. This finding may partially explain why the share of marketed output was slightly higher for Lira compared to Apac (Table 4).

Regarding the two districts in the Coffee-Banana System—Iganga and Hoima—there were some shared priority constraints and major differences, indicating the specificity of the problems to location. For Hoima, following the problem of wild animals and birds, inadequate capital was the second priority problem, pests and diseases the third, and inadequate labor the fourth. Comparatively, in Iganga, pests and diseases was the most significant constraint, followed by drought, inadequate capital, and low and fluctuating prices. In Table 13, an attempt is made to analyze constraints to maize farming over the years to see whether they are the same with those experienced during previous season.

Table 13: General constraints to maize production by district

Constraint	Percentage response (%)			
	Apac	Hoima	Iganga	Lira
Bad roads	3.04	0.00	0.00	0.00
Drought	2.13	4.81	5.20	**10.89**[3]
Expensive labor	0.00	0.00	0.00	0.00
High input costs	7.90	1.60	2.40	0.33
Inadequate capital	6.69	**17.65**[2]	**10.40**[3]	**10.23**[4]
Inadequate labor	1.82	4.81	2.40	6.60
Inadequate land holding	0.30	1.07	**8.40**[4]	0.00
Inadequate market	**15.81**[2]	**7.49**[3]	3.20	4.95
Lack of inputs	6.99	3.21	3.60	4.29
Lack of extension services	1.22	1.60	1.20	0.00
Lack of good means of transport	**8.81**[4]	2.14	3.20	1.65
Low price and price fluctuation	**19.15**[1]	**5.88**[4]	**11.60**[2]	**12.54**[2]
Low soil fertility	0.30	3.74	6.00	0.00
Low yields	0.91	1.07	2.40	1.65
Pests and diseases	**10.33**[3]	5.35	**20.40**[1]	**22.44**[1]
Poor storage	4.86	4.81	4.00	7.59
Theft	0.91	4.28	2.40	5.28
Unpredictable weather	2.13	2.67	2.40	4.95
Weeds	2.74	5.35	1.60	0.00
Wild animals/birds	0.91	**18.72**[1]	3.60	1.98
Other constraints	3.04	3.74	5.60	4.62
Total	100.00	100.00	100.00	100.00

Source: Survey 2001. Note: The four priority constraints in each district are highlighted in bold and ranked, beginning with 1 as the most constraining factor.

Looking at a longer time horizon beyond the previous season, it is evident that there are interesting issues that emerge. Some general constraints seem to be major challenges to farmers but were not given as key constraints in the previous season. On the other hand, there are constraints that seem to have emerged specifically during the previous season but were not important problems over the years. The differences in rankings between Tables 11 and 12 bring out this point.

While pests and diseases stood out as the number one priority problem in three out of four districts during the previous season, they did not emerge as the main constraint when farmers were asked to give the constraints that they generally face in maize production over the years. While pests and diseases have continued to be the most limiting in Iganga and Lira, low and fluctuating commodity prices and inadequate markets stand out as main constraints for Apac and Hoima generally over the years. It is possible that farmers feel that there is nothing that they can do to change marketing conditions and that might explain why they indicated pests and diseases as the priority problem during the previous season. Again, low commodity prices were ranked second in Iganga and Lira, yet this was not an issue in Lira during the previous season.

Interestingly, while inadequate land holding was not reflected as a priority problem in any of the districts during the previous season, it was a major constraint to farming in Iganga when farmers were asked to indicate the problems that they face generally in maize production. This fact is confirmed by earlier findings that show that farmers in Iganga have small farm holdings averaging 2.7 ha as compared to other districts like Apac with an average of 11.9 ha (Table 2).

Cattle Profitability and Productivity

Profitability of Cattle

Computation of cattle profits was slightly different from that of maize, an annual crop. Cattle are reared for several reasons, the primary objective being a store of value or savings. Contribution to household cash flow is a secondary objective. Therefore, computing pure economic profits may be incorrect. In this study, revenue is taken to be the value of the stock of cattle (not just the value of cattle sold) plus the value of cattle products sold. By the nature of cattle rearing in Uganda and lack of farm-level record keeping, it would be extremely difficult to compute cattle profits based on number of cattle sold. Cattle may be reared for several years before selling and realizing cash income from them. However, costs are incurred constantly to keep them alive. Economic profits are realized over the long-term. In the short-run, the value of existing stock can be used as revenue. Table 14 presents cattle profit per animal for the four districts, without differentiating among the types of cattle breeds reared. While there is variation in average profits per animal among districts, the difference is only statistically significant between Iganga and Hoima (p-value=0.008).

Table 14: Cattle profit per animal by district

Farming System	District	Profit (Sh)
Northern System	Apac	200,333
	Lira	226,478
Coffee-Banana System	Iganga	302,785
	Hoima	158,118

Source: Survey 2001

District-level comparison of cattle profits by breed was not possible because exotic and crossbreed cattle were not captured in the sample across the four districts. Only the indigenous cattle are reared in all four districts. Therefore, comparisons are made for profitability by breed without differentiating among districts. The differences in average profits are statistically tested (Table 15). There were three cattle breeds in the sample: exotic, crossbreed and indigenous. The comparisons indicate that there was no significant difference in profit per animal between exotic and crossbreed cattle, but a very significant difference existed in profits between exotic and indigenous cattle. Also, the difference in profits was very significant between crossbreed and indigenous cattle.

Table 15: Cattle profits (shs) per animal by breed

Exotic	Crossbreed	T-test (mean difference) P-value
1,185,668	1,417,062	0.7052
Exotic	Indigenous	
1,185,668	691,066	0.0031
Crossbreed	Indigenous	
1,417,062	691,066	0.0051

Source: Survey 2001

These results clearly demonstrate that rearing improved cattle brings more returns to farmers than rearing indigenous cattle. Yet, the adoption of improved cattle breeds by farmers remains very low (3% adopted crossbreeds; 7% exotic breeds) compared to the level of adoption by maize farmers (61%). The policy challenge, therefore, is to promote adoption of improved cattle breeds, and the improvement can be gradual from indigenous to crossbreed. Such an approach to upgrading is likely to be cheaper and more appealing to cattle keepers.

Regression Results

Table 16 presents the results of regression analysis for cattle profit as the dependent variable. All variables are in logarithms. The results indicate that there are three main determinants of cattle profitability. First, the sale price of cattle is important, the higher it is, the more profits. Profits are positively related to output price, hence the importance of ensuring that efficient markets exist. Second, the amount of land under pasture is a very important factor in determining cattle profitability. The more land under pasture, the higher the profits. Indeed, inadequate pasture was mentioned as a major constraint to livestock production (Table 18), implying that having pasture is important for livestock production. Third, the distance to an all-weather road is important. Living further away from a good road reduces cattle profitability, especially for milk, which is a perishable commodity. Farmers far from reliable road may get lower prices for their products compared to those close to good roads.

Table 16: Determinants of cattle profitability (dependent variable: cattle profits)

Variable	Coefficient	T-statistic	P-value
Cattle price	0.78	3.71	0.000
Land under pasture	0.46	9.24	0.000
Distance to an all weather road	-0.07	-1.62	0.109
Intercept	4.52	1.78	0.078
R^{-2} = 0.459			
N = 122			

To enhance farm-level profits from cattle rearing, it is absolutely critical that farmers are in easy reach of basic infrastructure, particularly markets and roads. The challenge is to ensure that the Marketing and Agro-Processing Strategy (MAPS) that has been developed under the PMA to address marketing problems at farm level is operationalized to ensure increased access to output and input markets, market information and better prices. While access to pastureland is important in explaining cattle profitability, the future lies in focusing on pasture productivity because land is becoming a limiting factor. This is in view of earlier findings of the relatively smaller farm size in Lira (5.6 ha) and Iganga (2.7 ha) and, consequently, the proportion of land allocated to livestock in these two districts being small as well (refer to Table 2).

Cattle productivity

Cattle productivity is simply measured by the amount of milk produced by lactating animals over the previous season. Another simple measure would have been live or carcass weight, but data on these measures were not collected. A comparison of milk yield reveals that there is no statistical difference between milk yield of exotic and crossbreed cattle, yet the differences are significant for exotic and indigenous, and crossbreed and indigenous as shown in Table 17.

Table 17: Milk yield (litres) per season by breed

Exotic	Crossbreed	T-test (mean difference) P-value
1736	823	0.1296
Exotic	Indigenous	
1736	465	0.0000
Crossbreed	Indigenous	
823	465	0.0051

Source: Survey 2001

Milk prices are similar regardless of the type of cattle breed reared and, therefore, profit differences are due to higher milk production by the improved cattle breeds as well as the higher prices for the live animals. Milk yield per exotic cattle is more than twice that of crossbreed cattle and about four times that of indigenous cattle. The average price for live exotic cattle is more than twice that of indigenous cattle and about one-and-a-half times that of crossbreed cattle. These findings underscore the importance of promoting adoption of improved cattle breeds.

Constraints to livestock production

Like in the case of maize production, in addition to cattle profitability and productivity, we analyzed farmer responses regarding what they considered to be constraints to cattle production. The responses were sought for constraints faced during the past few years as well as during the previous season. These were grouped into two categories: those that were crosscutting or common to all districts and those that were district-specific.

Crosscutting constraints

Without controlling for location, for both the previous season and, in general, over the years, pests and diseases remained the main constraint to livestock production (Table 18). The second major constraint across both time horizons was inadequate pasture, followed by high cost of inputs and lack of capital, in that order. The ordering of constraints was consistent for the entire sample. Present but less prominent across the districts, was the constraint of inadequate water for livestock production.

Table 18: Crosscutting constraints to livestock production

	Percentage Response	
Constraint	Previous Season	**Generally over years**
Lack of capital	**5.80**[4]	**9.04**[4]
Conflicts	0.00	1.53
Diseases/pests	**30.93**[1]	**22.80**[1]
Drought	1.42	2.93
High input costs	**10.57**[3]	**10.96**[3]
Inadequate pasture	**19.97**[2]	**16.31**[2]
Inadequate water	4.12	2.04
Lack of farm inputs	3.61	3.82
Lack of clean water	5.28	4.08
Lack of extension services	2.71	3.06
Lack of good means of transport	0.64	0.51
Lack of market	2.71	3.31
Low price and price fluctuation	1.93	4.46
Low yields	2.45	2.17
Poor breeds	1.42	2.17
Theft	1.55	4.71
Other constraints	4.90	6.11
Total	100	100

Source: Survey 2001

District-specific constraints

The major limitations to livestock production by district for the previous season as well as for the past few years are summarized in Tables 19 and 20, respectively. During the previous season, pests and diseases were the main constraint in all four districts, still followed by inadequate pasture; except in Hoima where high input costs featured as the second major constraint (Table 19). Pasture inadequacy was more severe in Iganga as well as Lira. This is probably explained by the much smaller farm sizes and, hence, a small proportion of land allocated to livestock production in these districts as compared to Hoima and Apac (Table 1). High cost of inputs was the third most constraining factor in Apac and Lira, while in Hoima and Iganga, the third main constraint was lack of capital. Interestingly, the lack of clean water for livestock production was important only in Apac during the previous season, but was very insignificant in neighboring Lira indicating the location specificity of this particular constraint, hence requiring targeted intervention.

In general, over the years, there are more variations in the constraining factors among districts when a longer time horizon is considered. High input costs were the main constraint in Apac and Hoima, while pests and diseases were the main constraint in Lira and Iganga (Table 20). Lack of capital was second in Hoima and Iganga, while pests and diseases and inadequate pasture were the second most constraining factor in Apac and Lira, respectively. There was no commonality among districts with regards to the third and fourth most constraining factors to livestock production, again reflecting the fact that some constraints are district-specific. For instance, theft of livestock was among the top four only in Hoima. The other factors in the top four but are district-specific include lack of extension services (Apac), lack of market (Iganga), conflicts (Iganga), and low prices and price fluctuation (Lira).

Table 19: Constraints to livestock production for the previous season by district

	Percentage Response			
Constraint	**Apac**	**Hoima**	**Iganga**	**Lira**
Lack of Capital	1.16	**11.66[3]**	**9.29[3]**	**4.67[4]**
Conflicts	0.00	0.00	0.00	0.00
Diseases/Pests	**18.92[1]**	**23.31[1]**	**32.86[1]**	**50.00[1]**
Drought	2.70	1.23	0.71	0.47
High Input Costs	**14.67[3]**	**14.72[2]**	4.29	**6.54[3]**
Inadequate Pasture	**17.37[2]**	**11.04[4]**	**27.86[2]**	**24.77[2]**
Inadequate Water	1.93	4.91	**6.43[4]**	**4.67[4]**
Lack of Farm Inputs	5.02	4.29	1.43	2.80
Lack of Clean Water	**10.81[4]**	5.52	0.71	1.40
Lack of Extension Services	7.34	1.23	0.00	0.00
Lack of Good Means of Transport	1.93	0.00	0.00	0.00
Lack of Market	3.74	1.84	6.43	0.00
Low Price and Price Fluctuation	2.70	4.91	0.00	0.00
Low Yields	3.86	1.23	2.14	1.87
Poor Breeds	2.32	3.07	0.00	0.00
Theft	0.00	1.84	3.57	1.87
Other Constraints	5.79	9.20	4.29	0.93
Total	100	100	100	100

Source: Survey 2001

Table 20: General constraints to livestock production by district

	Percentage Response			
Constraint	**Apac**	**Hoima**	**Iganga**	**Lira**
Lack of Capital	**8.33[4]**	**12.71[2]**	**17.53[2]**	3.30
Conflicts	0.00	1.69	**6.49[3]**	0.00
Diseases/Pests	**14.17[2]**	**11.86[3]**	**21.43[1]**	**35.90[1]**
Drought	1.25	3.39	1.30	5.13
High Input Costs	**14.58[1]**	**19.49[1]**	4.55	**7.69[3]**
Inadequate Pasture	**11.25[3]**	5.08	**21.43[1]**	**22.71[2]**
Inadequate Water	0.83	4.24	2.60	1.83
Lack of Farm Inputs	4.58	5.08	1.30	4.03
Lack of Clean Water	**8.33[4]**	3.39	1.30	2.20
Lack of Extension Services	**8.33[4]**	3.39	0.00	0.00
Lack of Good Means of Transport	1.25	0.85	0.00	0.00
Lack of Market	4.17	4.24	**6.49[3]**	0.37
Low Price and Price Fluctuation	4.17	4.24	1.95	**6.23[4]**
Low Yields	1.25	1.69	2.60	1.47
Poor Breeds	4.17	3.39	0.65	0.73
Theft	0.83	**9.32[4]**	5.84	5.49
Other Constraints	12.50	5.93	4.55	1.74
Total	100	100	100	100

Source: Survey 2001

V. Policy Implications

The findings of this study demonstrate that the differences in profitability and productivity are due to the type of technology used by farmers. Those that planted improved maize had higher returns per hectare than those that planted local (unimproved) maize. Similarly, farmers that reared improved cattle breeds realized higher profits and productivity per animal than those that reared indigenous breeds. The results of this study have several policy implications for PMA implementation.

First, it is important to promote the growing of improved maize varieties because they are more profitable than indigenous maize varieties across all farm sizes. A study by NIDA (2001) on assessing the socio-economic benefits of SASAKAWA Global 2000 interventions in Uganda also showed positive marginal returns to investment in the improved varieties over the local varieties. Farmer sensitization and education, through NAADS should play a significant role in this regard. Along with these, it will be important to support the evolution of stockists so that farmers can get the seeds at nearer places. As illustrated by this study, contact between farmers and extension agents plays an important role in profitability. The farmers' groups being formed under NAADS should provide opportunities for maximizing the benefits of extension. PMA interventions must be sensitive to the location-specific nature of farmer constraints. If the interventions are implemented broadly, their impact is likely to be less effective.

Second, cattle farmers should be encouraged to raise improved cattle breeds because they are more profitable than indigenous cattle. They yield more milk and the price for live animals is also higher. For example, milk yield per exotic cattle is more than twice that of the crossbreeds and about four times that of indigenous breeds. However, the predominance of indigenous cattle in all districts means that a lot of effort by NAADS will be necessary to bring about transformation among cattle farmers rearing indigenous cattle. There is no significant difference between exotic and crossbreeds in milk yield and profitability, yet the transition from indigenous to exotic can be costly, especially for poor farmers. Therefore, the policy challenge is to promote gradual upgrading from indigenous to crossbreeds—perhaps through artificial insemination or promoting bull exchanges among farmers. Pests and diseases are serious constraints to cattle rearing because they have two main effects—reducing the productivity of the infested animal, and increasing the production cost to the farmer. The high prevalence of pests and diseases emerges as the most critical problem facing maize production as well.

Third, farmers in northern Uganda should be encouraged and facilitated to grow improved maize and rear improved cattle breeds, which are as productive and profitable in this region as in the coffee-banana region, despite the seemingly unfavorable climatic conditions. This could be one way of increasing household incomes, and therefore reducing poverty, in the north were poverty trends have been on the increase. The fact that 78% of sampled farmers in northern Uganda had planted improved maize seed gives positive indications of a quicker uptake of improved technology when introduced and promoted. This is an opportunity that should be fully exploited.

Fourth, although expansion of land for maize production and pasture is an important determinant of profitability, this may be so in the short run. This is because land availability becomes a constraint, as the case was in Iganga district. Improved maize production and profitability should come from adoption of improved seeds. Similarly, increased livestock production must come from adoption of improved breeds and improved pasture

Fifth, we have also examined the findings of this study against PMA interventions. While the qualitative assessment of the constraints to production reveals that pests and diseases, both for crops and livestock, are major constraints to productivity, government interventions in the PMA are not aggressively tackling this problem. In the PMA, the government commits to handle pests and diseases that are of epidemic proportion, and argues that farmers ought to be responsible for purchase of chemicals to fight any other pests or diseases. It seems the problem needs a more integrated approach. In the short run, farmers complain about the high cost of inputs—among them, pesticides—yet government is limited in its ability to subsidize inputs. Additionally, even if farmers were willing to borrow and purchase the necessary inputs, rural micro-finance is not readily available. One of the PMA interventions is rural finance, but this is yet to be operationalized. In the long run, research has got to focus on developing pest and disease resistant maize varieties and cattle breeds. The research agenda also needs to be informed by the constraints facing farmers

Finally, the study did not establish why livestock farmers are not adopting improved cattle breeds. But what is clear is that non-adoption is not due to technology being unprofitable. Findings suggest, to some extent, that low adoption could be linked to the limited access to sizeable pieces of land, low literacy levels (since close to half of the farmers had only attained primary education), which could have resulted in limited appreciation of improved technologies. This is an area that warrants further investigation. The gender aspects of technology adoption also need to be explored further as this was not possible in this study where the majority of respondents were male.

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CHAPTER TWO

Wetland Diversity, Agricultural Productivity and Food Security in Uganda

Beatrice Okello and Rita Laker-Ojok

1.0 BACKGROUND

1.1 Introduction

Low and declining agricultural productivity contributes to poverty and food insecurity in Uganda. Forty-four percent of Ugandans lived below the poverty line in 1997 (APSEC 2000). While poverty rates are reported to be declining nationally, they are still very high in the rural areas, and statistics show that the poorest 20% of the population have become poorer. (Ibid.) Food insecurity is reportedly increasing in many rural parts of the country. Low and declining yields of food crops are cited as a primary cause for this trend (Sserunkuuma 2001, Pender et al, 2001). The struggle to meet the basic household needs of a growing population is putting increasing pressure on the Ugandan natural resource base resulting in soil depletion, deforestation, and wetlands degradation. The Plan for the Modernization of Agriculture (PMA) estimates that the cost to the national economy due to environmental degradation (including biodiversity loss, deforestation, soil erosion, water hyacinth and water contamination) lies between 4% and 12% of GDP (GOU 2000). The PMA concludes "if one attributes biodiversity loss, deforestation and soil erosion to activities in the agricultural sector, then the agricultural sector alone is responsible for 86% to 91% of the environmental degradation, in monetary terms" (Ibid. p. 62).

Induced innovation theory suggests that environmental degradation can be self correcting as population growth, increasing resource scarcity, and environmental externalities induce new agricultural and resource management practices (Boserup 1965) and new forms of collective regulation of common property resources (Ruttan and Hayami 1984). However, this early work on induced institutional innovation may be overly optimistic. It tends to overlook the fact that long run institutional evolution and the corresponding pathways of development are dependent on the initial stock of social capital, on the actions by the state, and on the distributive consequences of institutional change (Zeller et.al. 2000).

Vosti and Reardon (1997) conceptualized a critical triangle that links three development objectives: economic growth, poverty alleviation and environmental sustainability, emphasizing the importance of simultaneous consideration of all three development objectives and the potential linkages and trade-offs between them. Continued agricultural growth is necessary in most fragile lands of Sub-Saharan Africa. Agricultural development that concentrates only on the high potential areas has resulted in biased development that leaves the majority of the population wallowing in poverty. Agricultural growth must be achieved, however, within the context of sustainable use of the natural resource base. In addition, such growth must be equitably distributed in order to alleviate poverty and reduce food insecurity. An understanding of the three objectives of growth, poverty alleviation and the sustainable use of natural resources (the elements of the critical triangle) and the linkages between them is fundamental to the formulation of appropriate development strategies.

In the words of Babu and Hazell (1998) "Integrating the livelihood needs of people living in fragile areas with sustainable management of natural resources is a fundamental challenge facing governments and development agencies… The most important contributing factor towards degradation of fragile lands in Sub-Saharan Africa is a nexus of poverty, rapid population growth and inadequate progress in increasing crop yields."

This research effort seeks to explore in depth the elements of the critical triangle of development within the context of the problem of wetlands utilization in the Lake Kyoga basin of central Uganda. Wetland biodiversity was selected as a critical measure of the sustainability of natural resource use. Food security was selected as the key measure of poverty alleviation, while agricultural productivity was selected as a measure of agricultural growth. The research seeks to explore the determinants of each of these elements of the critical triangle and to explore the relationship between them. This work complements the efforts of other researchers to analyze the implications of alternative development pathways on land and resource management in Uganda (Pender et.al. 2001).

1.2 Research objectives and Questions

The Research Objectives

This research was designed to respond to the policy needs of various constituencies:

- Policy analysts and decision-makers need to be able to quantify the direction of current trends and predict the extent of the wetlands diversion problem, now and in the foreseeable future, in order to formulate well-informed and appropriate policies. The formulation of policy should not be random. It should be guided by research.

- Local authorities need to understand the regulations and the underlying issues in order to arrive at acceptable levels of community compliance.

- Farmers need to understand the trade-off, assess opportunities, risks and prospects in increasing production and profits without destroying wetland diversity.

The Research Questions

These objectives lead to the following set of related research questions:

- What are the characteristics of the alternative forms of wetland utilization? What is the demand for the respective types of wetland utilization and what is the economic contribution of each? How has this changed over time?
- What is the current extent of wetland utilization for agricultural purposes, and what has been the historical trend?
- What is the food security situation in the Lake Kyoga basin? What are the factors that influence its distribution among households? How has this changed over time?
- What are the determinants of agricultural productivity and how does this relate to food security and wetlands utilization?

1.3 The Structure of the Report

The report is structured into six major sections. The first lays the background context and outlines the research questions addressed. The second section presents the importance of Uganda's extensive wetland resources and the regulatory context. Section Three presents the literature review. Because this research seeks to explore the inter-relationships between the three elements of the critical triangle, an extensive literature review was necessary to explore all aspects of each of these elements and understand their policy context. The review therefore, begins with a summary of the literature on the economic valuation of wetland resources in Uganda. The importance of wetlands biodiversity is explored next. The third topic is food security as a critical component and indicator of poverty. The fourth topic is agriculutral productivity with an emphasis on the policy context for productivity in Uganda. Lastly we review the literature on irrigation and its contribution to agricultural productivity in the Ugandan context.

The last three sections of the paper present the primary research, beginning with the presentation of research methodology in Section Four. Section Five presents the data analysis and its interpretation. This includes both the qualitative and historical trend data collected by means of the Participatory Rural Assessment (PRA) and the quantitative survey data analysis. The final section discusses the findings in light of the literature and draws conclusions about the relationships between the elements of the critical triangle in the Ugandan context. Policy recommendations are drawn from this analysis.

2.0 THE IMPORTANCE OF UGANDA'S WETLANDS

About 18% of the area of Uganda is open water. In addition, Uganda possesses some major wetland resources, including 8,832 sq. km of swamps; 365 sq. km of swamp forest and 20,392 sq. km of other wetlands[7]. Around the extensive and widely distributed lakes and many of the country's rivers, especially in the lowland areas bordering the River Nile, there are elongated tracts of papyrus and grass swamps. Permanent wetlands are estimated to cover about 3.7 % of the country's land area. In addition there are about 2,191,500 ha of seasonal swamps, which bring total wetland area to just over 15% of Uganda's land area.

2.1 The Study Area

Lake Kyoga is a large shallow lake in central Uganda into which the White Nile flows and out of which, eventually, the Blue Nile proceeds on its journey northward. Along the fringes of Lake Kyoga there are a variety of wetlands, both permanent and seasonal, which exhibit unique soil and plant conditions adapted to the saturated conditions and characterized by an accumulation of organic materials that decompose slowly. These wetlands are integrally linked to the ecology of the upland and lake systems that they border. Lakeside communities in this area closely follow the natural cycle of the lake, adjusting to the seasonal movements of the fish, vegetation growth and changing water levels. With the rise in population, and the subsequent demand for more resources to sustain livelihoods, the Lake Kyoga wetlands and their benefits are now under threat. Small but continuous 'nibbling' at wetland edges has reduced the wetland area, mainly in the seasonal swamps. The damage to permanent wetlands, however, is limited by their inaccessibility and the lack of drainage technology. These developments have taken place without a well-developed social framework to regulate wetland use. The limited understanding of how wetlands work, what the immediate and long-term impacts of modifications may be; and the economic value of wetlands as compared to the economic benefits of alternative uses; is compounded by the lack of clear legal framework**.** (National Wetlands Conservation and Management Programme, 1999)

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[7] A large area of swamps adjacent to Lake George is so far the only site in East Africa protected by the Ramsar Convention. (Frazier, 1999)

2.2 Wetlands Utilization in Uganda

Most development projects focus on only one attribute of the wetlands, to the detriment of the rest. There is now a growing appreciation, however, that the potential of wetland ecosystems for meeting development needs lies in maintaining their functional integrity rather than converting them to single purpose use. If managed sensitively, these ecosystems can provide a wide range of products and services.

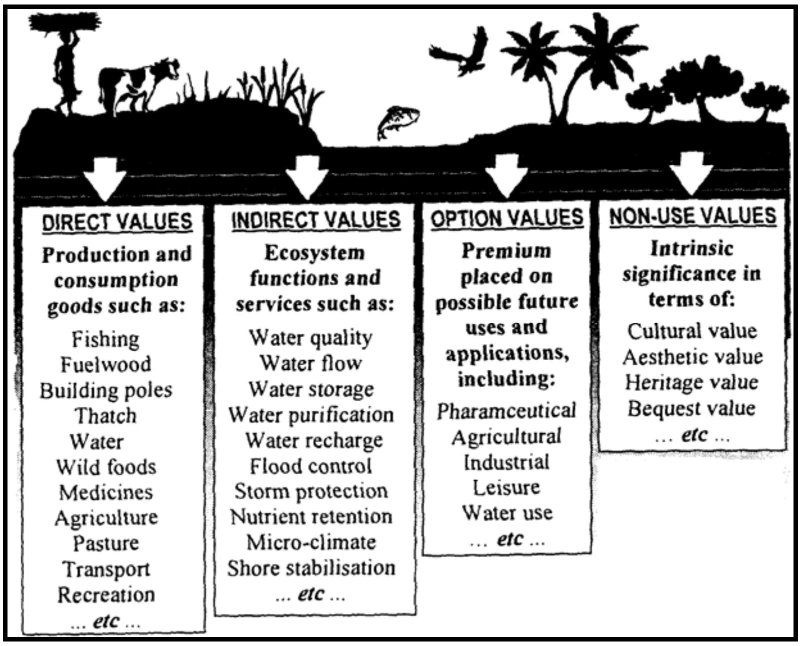
In Uganda wetlands have traditionally contributed a range of products essential to the rural community. Wetlands are an important source of fish, meat and skin from wild animals, as well as medicines from various plants, and famine food reserves. Papyrus and reeds for mats, grass for brooms, and fuel wood are also harvested from wetlands. Other resources include clay for bricks and pots, and sand, poles and rope for building. Water, both for humans and livestock, is obtained from the swamps directly as well as from springs, streams, and rivers fed by the wetlands. Wetlands are used for dry season grazing and to grow crops such as rice, sweet potatoes, sugarcane, and vegetables, both for sale and home consumption. In some areas wetlands also provide major opportunities for transport.

In addition to these clearly observable uses, the wetlands serve other important ecological functions which are more difficult to perceive. These functions include:

- Groundwater recharge, including important filtration functions[8].
- Groundwater discharge, as drainage points for groundwater returning to the surface.
- Floodwater control (because they store precipitation and release run-off evenly).
- Shoreline stabilization, Reeds and grasses slow water speed, thus reducing erosion and downstream sedimentation.
- Biomass export – dense fish, cattle or wildlife production in swamps feed neighboring downstream environments with nutrients that are carried by water flow
- Microclimate stabilization – overall hydrological, nutrient and material cycles, and energy flows of the wetlands help to stabilize local climatic conditions such as rainfall and temperature.
- Biological diversity - the inaccessibility of the wetlands has drawn species which, although not confined to wetlands, are dependent upon the shelter they now provide. In addition, wetlands are important as a genetic reservoir for certain unique plant species and provide important habitats for migratory birds.

These essential wetlands functions are illustrated in the following diagram.

[8] The small communities surrounding Lake Kyoga depend upon over 60 boreholes recharged from this extensive wetland system.



Source: National Wetlands Conservation and Management Programme (1999)

2.3 Wetlands Regulation in Uganda - The Legal Context

Wetlands (including swamps, marshes, lakes, rivers, estuaries, and bogs) are among the richest of natural habitats in terms of biodiversity. Half the world's wetlands are estimated to have been lost in the 20th century, mostly in the developed world. While urban and infrastructure development, malaria control, and recreational use have been important reasons for wetland conversion, agricultural use has been the leading culprit. Wetlands drainage and changes in the water regime resulting from agricultural use have a serious impact on the species that require particular characteristics of water chemistry, temperature, and flow patterns for their survival (Revenga et al. 2000).

While most developed countries have now established controls on wetland drainage, and some have even initiated wetland habitat restoration, in many developing countries conversion of wetlands is still considered an important safety valve to relieve agricultural land scarcity. Until recently in Uganda, drainage of swamps for agricultural purposes was encouraged. Approximately 1,620 ha had been drained by 1964. NEMA estimates that the total wetland area reclaimed for agriculture is currently about 3,000ha.

Uganda justifiably boasts of being the second country world-wide to have a Wetlands Policy and the only country to have a government institution dedicated to wetland management. This distinction makes Uganda an example for developing nations wishing to conserve their wetland resources through policy development. The issue of wetlands conservation first gained attention on the political scene in 1986 when the NRM Government banned large-scale drainage of wetlands until a National Wetlands Policy could be put in place. The National Wetlands Conservation and Management Programme was established in 1989, with technical assistance from the World Conservation Union (IUCN), based in the Department of Environment Protection. The National Policy for the Conservation and Management of Wetland Resources (1994) was quickly followed by the National Environment Management Statute in 1995.

This statute established the National Environment Management Authority (NEMA). It also assigns the responsibility of wetland management in Uganda to the Wetlands Inspection Division (WID), Ministry of Water, Lands and Environment. The division assists central and local government to develop and apply a long-term policy for the conservation and management of wetland resources and to acquire the necessary capacity (skills and finances) for implementation. According to the Environment Statute: "Without written approval from The National Environment Management Authority (NEMA), it is now an offence for any person to:

- Reclaim or drain any wetland,
- Erect, construct, place, alter, extend, remove or demolish any structure that is fixed in, on, under or over any wetland;
- Disturb any wetland by drilling or tunneling in a manner that has or is likely to have an adverse effect on the wetland,
- Deposit in, on, or under any wetland any substance in a manner that has or is likely to have an adverse effect on the wetland;
- Destroy, damage or disturb any wetland in a manner that has or is likely to have an adverse effect on any plant or animal in a wetland;
- Introduce or plant any exotic or introduced plant or animal in a wetland".

These all-encompassing restrictions, however, are qualified by the statement that "NEMA will exempt traditional uses of wetlands from these restrictions and the Authority shall, in consultation with the lead agency, establish guidelines for the sustainable management of all wetlands in Uganda." (National Wetlands Conservation and Management Programme, 1999. pp.6-7).

The guidelines for sustainable management referred to in the Environment Statute were passed in 2000. The National Environment (Wetlands, River Banks, and Lake Shores Management) Regulations were intended to give specificity to the general principle of "ensuring sustainable use of wetlands compatible with their hydrological functions and services." The Regulations establish a District Environment Committee and local environment committees, although the composition of the local environment committee and the distinction between it and the local government council is not specified. These local committees or councils are given broad powers to regulate wetlands activities.

The Regulations require a permit, issued after completion of an Environmental Impact Assessment (EIA) for almost any non-traditional activity in wetlands. Regulated activities include brick making, cultivation (when non-traditional or when exceeding more than 25 percent of the total area of a wetland), drainage, and commercial exploitation. Traditional cultivation of less than 25 percent of the total area of a wetland is not subject to the permit requirements. Although NEMA has been undertaking a media campaign telling farmers not to cultivate within 100 meters of the edge of the swamp.

Traditional harvesting of papyrus, medicinal plants, trees, and reeds; fishing; water collection; and hunting also do not require a permit (§§11-12, Second Schedule). The regulations do not address grazing, except to note that the lower local government council can regulate it. Grazing is not included as one of the traditional activities that can be carried out without a permit, nor is grazing included as a regulated activity requiring a permit (§§7(4)(b), 11(2)(a)-(e), Second Schedule). Where a permit has been granted for a regulated activity, any permit holder is required to restore the wetland within one year of expiration or revocation of the permit (§16). Local government is given responsibility to inventory, map, and inspect wetlands. Any person who reclaims, drains, destroys, damages, adversely disturbs, or removes soil from a wetland is guilty of an offence punishable by up to three months imprisonment or a fine up to three million shillings (§37-38). Every landowner, occupier or user who is adjacent or contiguous with a wetland is charged with the duty of maintaining the ecology of the wetland and is guilty of an offence if he refuses or neglects this responsibility (§17).

The classification of wetlands for management purposes stresses the extent to which that wetland provides vital environmental services and the extent to which it is currently under threat (National Wetlands Conservation and Management Programme, 1999). This classification is supposed to be the basis for regulatory decisions by local authorities. The criterion is presented in full in Appendix 1 and the restrictions for each classification are presented in Appendix 2. Unfortunately, it is not easy for local committees, who are non-technical people, to determine the classification to which a particular wetland belongs. Since 1993 the NWP has been undertaking an on-going National Wetlands Inventory (NWI) under which all Uganda wetlands are to be surveyed, described, quantified and mapped. Interestingly, even the District Inventory Reports, which are prepared by technical staff, do not specify the classification of each of the inventoried wetlands. Current uses and threats are simply described in general terms with no clear guidelines as to the extent to which various activities should be specifically allowed or controlled. The Inventory, therefore, does not provide communities with the information they need to set and enforce local policy guidelines.

Muhereza and Bledsoe note that a booklet of guidelines for smallholder paddy rice cultivation in seasonal wetlands was prepared in 2001 and that a similar guide for general wetland edge cultivation was in preparation. These guidelines are “a strong tool for establishing and informing the public.” The guidelines, however, appear not to be enforceable “regulations”, as indicated by repeated references to “recommendations” (Ibid. p. 41).

Despite the extensive legal framework for wetlands regulation in Uganda, the reality on the ground is far different from that depicted by law. The nature of property rights in Uganda’s wetlands remains very unclear in people’s minds, despite government’s insistence that all wetlands are government property. Historically wetlands have been allocated to individuals under various mechanisms, including mailo, leasehold (after the 1975 Land Reform Decree) and customary tenure arrangements. Because the 1995 Constitution stated that, “the land belongs to the people” these “land owners” believe the wetlands to be part of their property. Yet the Constitution also entrusts all natural resources, including wetlands, to the state, which holds them for all the citizens of Uganda. This contradiction is far from resolved. Because ownership is unclear, landowners and wetland users have little incentive to invest in wetland reclamation and generally continue to pass on externalities arising from wetland use, to the detriment of nearby communities. In many places, wetlands that were traditionally use by cattle keepers for dry season grazing have become points of serious contention between cultivators and grazers.

In practical terms, enforcement of wetland regulations remains extremely limited. The National Wetlands Department has only four staff members, and relies on the districts to implement wetland regulations. District staffs have limited capacity for enforcement. The Environment Department in each district is really a single officer. The Wetland Programme itself has noted with concern the widespread problem of political interference in the enforcement of wetland regulations. As appointees, the District Environment Officers are answerable to elected district council members who are hesitant to make themselves unpopular by preventing their constituents from developing wetlands. At the local level “the wetland supervisor and the wetland user are one and the same person” (National Wetland Programme 2000b).

In their recommendations with respect to the Land Sector Strategic Plan, Muhereza and Bledsoe argue that the failure of the various laws and regulations to openly acknowledge the reality of existing non-conforming uses is "unrealistic and counterproductive". While noting that the Wetlands Sector Strategic Plan of 2001 acknowledges the extent of non-conforming uses and makes these a factor in the plan's objectives, they urge lawmakers to ensure that new laws set out specific solutions to the conflict, and that existing laws and regulations be amended. They strongly support the potential of Communal Land Associations to implement common land management schemes to address the problem of non-conforming uses. Finally, they urge government to develop legal regulations that specifically address the details of what is and is not permitted with respect to grazing, cultivation and brick making in the wetlands.

Summary of Recommendations

The literature review and subsequent field research experience raise the following policy issues and recommendations:

- There is limited understanding of the economic value of wetlands as compared to the economic benefits of alternative uses; hence the need for primary research to answer this critical question.
- It is important that local communities be specifically advised in writing of the classification of their local wetland resources and the regulations applying to that classification, so that appropriate local utilization policies can be enacted and enforced. PRA interviews clearly revealed that communities and local authorities do not have this information.
- The "ownership" of wetlands remains a point of contention. Households living in the vicinity of extensive wetlands clearly feel that they have traditional use rights and ownership privileges related to the wetlands. (54% of the survey respondents reported that they "owned" wetlands.) This leads to severe problems of non-conforming use.
- Specific legal regulations providing detailed guidelines on grazing, cultivation and brick making need to be formulated and widely disseminated. The regulations regarding wetland grazing rights need further clarification both to protect the rights of the traditional grazers, and to limit uncontrolled grazing that threatens the modernization of cultivation activities and investment in environmentally friendly irrigation practices.
- The formation of Common Land Associations to implement wetlands management schemes for the benefit of the community at large needs to be actively piloted and the resulting lessons promoted for broader implementation.

3.0 LITERATURE REVIEW

3.1 Economic Valuation of Natural Resources

The general economic principles for valuing natural resources are well-known, but they have generally been implemented on a fairly macro scale and rarely provide the detailed information needed to guide local natural resource utilization decisions. For example, Emerton and Muramira (1999) estimated the total economic benefits of natural resources in Uganda as a whole at about US $ 700 million annually, and the annual costs as about US $ 315 million (mainly production foregone). They observed that "the highest value assets for tourism are the open, relatively less fertile plains and their mega fauna, whereas the areas of greatest conservation interest are the fertile mountain forests and wetlands which, it has been said, offer tourists little but bugs, rain and difficult access."

Similarly, Howard (1995) used social-cost-benefit analysis of Uganda's protected areas to examine the Total Economic Value (TEV) of the country's National Parks, Wildlife Reserves, and Forest Reserves. He estimated that the benefits were worth US $ 123 million annually. This estimate included revenues derived from tourism, timber and game utilisation; non-market produce such as firewood, building poles, game meat and thatching grass used by local people; environmental services such as provision of clean water, maintenance of downstream fisheries, pollution control, and climate regulation; and the maintenance of biodiversity and other attributes which provide options for future development, and are valued for cultural, moral or religious reasons. On the other hand, however, Howard estimated the costs of those same protected areas at US $ 200 million annually, more than half of which was attributed to the opportunity costs of land. While in 1995 it appeared to be in Uganda's short-term financial interest to maintain the country's protected areas (largely on account of US $ 11 million contributed annually by donors), clearly the long term benefit cost ratio was not promising. This concern has been seconded by Archabald and Naughton-Treves (2001), who found that no tourism revenues had been disbursed to local communities by the UWA between 1998 and 2001, due to administrative complications (Pomeroy et.al. 2002).

Pomeroy et.al (2002) noted, "A significant gap in our assessment of the importance of Uganda's major ecosystems is our limited ability to assign monetary values to their many goods and services. In particular, it is hard to ascribe values to particular ecosystems."

This study undertook to obtain specific estimates for the current value of wetlands utilization to households bordering on the Lake Kyoga wetlands system. Results are reported in section 5.3 below. It was not possible, however, to use ex-post survey methods to estimate the costs of such utilization in terms of alternative production foregone. Thus while the data can inform us about the current use values it cannot advise on whether such utilization is optimal.

3.2 Biodiversity

Biodiversity plays a critical role in supporting rural livelihoods, agricultural production, and ecosystem functions that is often unrecognized and under valued. All societies draw on a wide array of ecosystems, species, and genetic variants to meet their ever-changing needs. Biodiversity is the source of current and future wealth, supplying all our food, much of our raw materials, a wide range of goods and services, and the essential genetic materials for agriculture, medicine, and industry. Kate and Laird (1999) estimate the contribution of biodiversity to agriculture and industry at US$500-800 billion per year. In addition, people spend billions of dollars to appreciate nature through recreation and tourism.

Wild biodiversity is essential to agricultural productivity and sustainability. Various species of birds, bees and bats pollinate plants[9]. Earthworms, microorganisms, dung beetles, and vultures, contribute to the decomposition of wastes. Birds, primates, small mammals and fish help to disperse seeds. Living things in the soil, including arthropods, earthworms, nematodes, and

[9] Pollination and cross-pollination help flowering plants reproduce. While wind-blown pollen works for some, for many others an animal pollinator is required. Bats, bees, beetles, and other insects are the principal pollinators of fruit trees; most important oil crops; coffee; coconut; and major staple food crops like potato, cassava, yams, sweet potato, taro, and beans (Prescott-Allen and Prescott-Allen 1990). Worldwide declines in populations of pollinators for economic plants are threatening both the yields of major food crops and the biodiversity of wild plants.

mollusks build soil, facilitate the movement of air and water within the soil, and regulate nutrient cycling (Pfiffner 2000). Soil invertebrates and microorganisms invisible to the naked eye may be even more important for the functioning of the ecosystem, providing critical links between the atmospheric, terrestrial, and aquatic systems. Wild plants, animals, and ecosystems are all essential to a well-functioning agro ecosystem. "Because natural ecosystems and associated wild biodiversity help maintain the chemical balance of the earth's atmosphere, protect watersheds, renew soils, recycle nutrients, and provide many other ecosystem functions essential to human welfare, they are in a sense priceless because they are essential to life and cannot be replaced." (McNeeley and Scherr, 2001)

Scientists agree that biodiversity today is being lost at a rate that is two to three times faster than is normal in geological history (Wilson 1985). The latest IUCN figures indicate that nearly 24 percent of all species of mammals, 12 percent of birds, and almost 14 percent of plants are currently threatened. Some experts calculate that if present trends continue, at least 25 percent of the world's species could become extinct, or be reduced to tiny remnants, by the middle of this century. While most of the extinctions in recorded history took place in the USA, Australia, and on Pacific islands, the threat of extinction is now especially pronounced in the developing world. Uganda is not yet on the list of the top 25 countries in terms of threatened species, but both Kenya and Tanzania are. (IUCN 1997.) Clearly this is an area of concern, but must be balanced against the ever-pressing food needs of the region.

Some experts suggest that in 30 years we will need at least 50 to 60 percent more food than we produce now, in order to meet global food and nutrition needs and enjoy at least a modest degree of greater affluence. Yet agricultural systems are already threatened by eroding soils, declining freshwater stores, depleting fisheries, deforestation, desertification, natural disasters, and global climate change; all factors that make it increasingly difficult to raise productivity.

According to the Global Biodiversity Assessment (Heywood and Watson 1995), "overwhelming evidence leads to the conclusion that modern commercial agriculture has had a direct negative impact on biodiversity at all levels: ecosystem, species and genetic…" Agricultural production to feed the growing population has converted natural ecosystems characterized by high levels of diversity into greatly oversimplified ecosystems, led to pollution of soils and waterways, and hastened the spread of invasive alien species.

This threat to biodiversity poses a major dilemma for modern society. On the one hand, modern intensive agriculture has made it possible for the expanding human population to eat more food. On the other hand, agriculture is now spreading into the remotest parts of the world, often in highly unsustainable forms that further reduce wild biodiversity and undermine the sustainability of the global food production system.

3.2.1 Biodiversity in Uganda

Most of the world's species are found in the tropics, frequently in developing countries with limited resources to devote to the conservation of biodiversity. Uganda is one of the tropical countries blessed with a generally warm, moist climate and a diverse range of habitats. This environment supports a diverse set of land use activities to feed its population. Warm, moist climates support high levels of biodiversity. Uganda has 311 species of mammals, making it one of the top ten countries in the world in mammal biodiversity. (McNeely et al. 1990) In fact, Uganda may well have more than a quarter of a million species of living things, including 1010 species of birds and 330 species of mammals (National Biodiversity Data Bank, unpublished data cited in Pomeroy et. al. 2002).

Unfortunately, Uganda is losing its biodiversity rapidly – one source estimates that as much as 10% is lost each decade. Rapid population growth, estimated to reach 25 millions by 2005 (UBOS 2000), is a prime reason why Uganda is losing biodiversity so rapidly. While agricultural production clearly needs to keep pace with population growth, in Uganda this has been achieved primarily through the expansion of the area devoted to crop production, rather than through intensification and increasing productivity (IFPRI 2001). The vast majority of Ugandan farmers are smallholders, growing a mixture of low-yielding varieties on small fragmented plots of land. A crucial question, therefore, is the extent to which increased productivity of the land can be achieved while simultaneously reducing the rate of biodiversity loss (Chemonics 2001). It may be that a much larger population can be supported through intensification of agriculture in Uganda. With better terms of trade and a shift from agriculture to alternative forms of employment it might even be possible for Uganda's system of Protected Areas to expand beyond the 33,000 km^2 of existing National Parks, Forest Reserves and Wildlife Reserves (FNCMP 1999). But the pressure on these areas seems certain to intensify in the shorter term.

Land use changes such as clearance for agriculture and swamp drainage are usually identified as the primary culprits driving the process of habitat loss, but there are many other factors leading to biodiversity loss, amongst them – the loss of tree cover to meet growing demands for timber, fuel wood and charcoal; increasing industrial pollution which has especially affected the ecology of Lake Victoria; and the introduction of exotic species, most notoriously the Nile Perch.

These facts have led many in the environmental community and the general public to promote the establishment of "protected areas" where human use—in particular agricultural use—is restricted. Such aggressive efforts to conserve wild biodiversity, however, can reduce the livelihood security of rural people, especially the poor in developing countries (Pimbert and Toledo 1994). It is important to manage biodiversity through a combination of conservation measures and improved and diversified agricultural systems, which can increase incomes and household nutrition, reduce livelihood risks, and provide collateral benefits from enhanced environmental services. Impacts on the poor depend on how biodiversity benefits are achieved. Alternative conservation options are available besides just "locking away" resources on which the poor depend for their survival. Agricultural landscapes need to be designed more creatively in order to take the needs of the poor into account while pursuing biodiversity objectives.

A central challenge of the 21st century will be to achieve biodiversity conservation and agricultural production goals at the same time—and, in many cases, in the same space." New approaches to agricultural production must be developed that complement natural environments, enhance ecosystem functions, and improve rural livelihoods. (McNeeley and Scherr, 2001)

3.2.2 Summary of Issues and Recommendations:

- Without urgent action to develop agriculture in appropriate directions in Uganda's biodiversity-rich areas, wild biodiversity will be further threatened. Additional destruction of natural habitats, and therefore of wild biodiversity, will lead to the loss of the numerous current and future benefits these areas provide to rural populations.

- Clearly, the effort to increased agricultural productivity while simultaneously reducing the rate of biodiversity loss must be the primary objective of Uganda's future agricultural policy. Only by feeding more people on less land, can fragile environments be protected and biodiversity preserved.
- The potential of micro-irrigation to enhance productivity in a manner that is environmentally friendly must be actively explored.

3.3 Food Security

The term food security first came into prominence at the 1975 World Food Conference. Since then the definition of food security has broadened considerably. Initially food security meant avoiding transitory shortfalls in the aggregate supply of food at the global or national level. By the 1980's however, the specter of famine in the midst of global plenty, made it clear that inadequate global food supply was not the cause of hunger. Sen's work focused global attention on the issue of chronic poverty resulting in the lack of household and individual entitlements as a cause of food insecurity. Thus the concept of food insecurity has evolved to address the critical problems of inadequate access and unequal distribution at the household level (Staatz, et.al. 1990). Hoddinott (2001) estimates that there are approximately 200 definitions of food security[10]. He defines food security as "the condition in which a population has the physical, social, and economic access to safe and nutritious food over a given period to meet dietary needs and preferences for an active life" (Hoddinott, 2001 P. 39). He further elaborates that food security involves availability and access to food by all at all times. Availability relates to communities; while access relates to households. Availability is defined, as the capacity of communities to obtain the supplies of food required to feed everyone that lives there and is a function of total food supply. Access refers to the capacity of households to obtain food. This dimension of food security relates mainly to individual household wealth.

Hoddinott makes an important distinction between "process indicators," which describe food supply and food access, and "outcome indicators," which describe food consumption. Many studies have found that process indicators are insufficient to characterize food security outcomes. Chung et al. (1997) found little correlation between a large set of process indicators and measures of food security outcomes. Similarly IFAD found little correlation between area-level food production and household food security. (IFAD 1997, 13)

Household food security is understood to be a complex function of access to capital (land, tools, livestock, working capital), human capital (labor, knowledge, skills and management), infrastructure (access to markets, employment opportunities, health care and sanitation), and environment (physical, social and policy). For this reason, no single indicator is adequate to measure household level food security. For purposes of this study a food security index was created for each household from the survey data, which incorporated measures of the adequacy of food consumption, frequency of food shortages, and extent of inclusion of animal protein in the diet. The concept of the food security index is an outcome indicator that was modified from earlier work by John Staatz in West Africa. The data analysis, thus, sought to understand the

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[10] USAID for instance includes food utilization (in addition to food availability and food access) as part of the definition of food security, whereas FAO, IFAD and UNDP include only food access and food availability. The PMA defines food security as "the ability to provide adequate food for the household throughout the year, whether through adequate food produced by the household or by households earning enough incomes to be able to purchase food on the open market."

factors that explain household level variations in food security in the Lake Kyoga catchment area and relate it to the diversity of wetlands utilization, and agricultural productivity.

3.4 Productivity

It is widely recognized that per capita productivity and food production have declined in sub-Saharan Africa over the past 20 years. The implications of agricultural stagnation in Africa are serious and diverse. Food insecurity (at all levels from household to national) has increased. Africa is the only continent where the number of hungry people has increased and is projected to increase further (World Bank, 2000; UNDP 1997). Agricultural investment overall has stagnated[11].

Despite its poor performance in Africa in recent years, agriculture remains the most likely source of significant economic growth in the long term. Historical experience suggests that agricultural growth may be a prerequisite to broad based sustained economic growth and development (DFID, p.3). This was certainly the case in virtually all the world's developed countries. More contemporary experience demonstrates that, with few exceptions, overall economic growth has been most rapid in countries that have experienced significant agricultural growth. Rapid agricultural growth, supported by the public infrastructure investments made to promote it, has provided a powerful motor for growth in rural non-farm economies.

Not only is agriculture essential to economic growth, but DFID (2002) contends that there is strong evidence that agricultural growth benefits the poorest segments of the population. Strong agricultural growth has been a feature of countries that have successfully reduced poverty such as India, Bangladesh, Indonesia and China[12]. A recent study covering 58 developing countries concluded that a 10 per cent increase in agricultural productivity was associated with a reduction by 6 per cent in the proportion of people living on $1 a day[13]. For 16 sub-Saharan African countries included in the study, there was an almost one to one relationship. No equivalent relationship, on this scale, could be found for either manufacturing or services, whether in rural or urban areas.

There are a number of reasons why agriculture is particularly important to growth and development in Africa:

- Agriculture provides the primary and major source of domestic savings crucial to investment in other sectors.
- Early industrial development is often based on the processing of agricultural products.
- The rising incomes of small farmers and agro-processors are usually spent on locally provided goods and services. Agricultural growth generates demands for the products and services of other poor people. The fortunes of rural traders, brick-makers, carpenters and

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[11] Gross capital formation in agriculture in SSA fell from 21.9% of GDP in 1980 to 16.5% in 2000.

[12] *Human Development Report*, 1997. UNDP: New York.

[13] Lin Lin et al. 2001.

food vendors are closely tied to those of local agricultural enterprises[14]. Estimates of the multiplier effect on other sector resulting from increased farm output range from 1.3 to 1.9[15].
- Agricultural growth also affects poverty through the lowering of food prices[16]. Food constitutes over 70 per cent of the expenditures of poor people (both rural and urban). Market mechanisms that deliver food at lower and more stable prices enhance food security and reduce hunger.
- Agricultural trade generates foreign exchange needed for essential public services.

Agriculture in Africa, however, faces many challenges. Maintaining and increasing productivity in the medium term will require investment in infrastructure, knowledge and technology systems, including a greater emphasis on sustainable water management and more efficient field level water use.

3.4.1 Productivity in the Ugandan Policy Context

In the context of a highly agrarian country like Uganda, where the vast majority of poor people make their livelihoods as semi-subsistence smallholder producers, economic growth, poverty alleviation and agricultural development are inextricably interlocked with the issue of agricultural productivity. For this reason, Uganda's policy agenda, which is fundamentally grounded in the need to alleviate poverty, focuses broadly on the objective of "Agricultural Modernization" as the engine of economic growth. Two central policy documents reiterate these principals – the Poverty Eradication Action Plan (PEAP) and the Plan for the Modernization of Agriculture (PMA). Both were strongly influenced in their development by the Uganda Participatory Poverty Assessment Project (UPPAP)[17], which was undertaken with World Bank funding in the late 1990's.

It is estimated that only one third of Uganda's 18 million hectares of arable land is cultivated. Productivity of the land under cultivation is low and declining. Access to land is varied among different social and economic groups and by region. However, most people in Uganda have access to some land. In Uganda, the poorest segment of the population is comprised not of wage-labourers but of small-scale farmers with limited access to markets for their products. Uganda has three main categories of farmers: subsistence, semi-commercial, and commercial. Subsistence farmers who produce predominantly for household consumption are the majority. Thus, transforming agriculture requires addressing the constraints of subsistence farmers.

UPPAP consultations with poor farmers revealed that critical productivity related constraints included: lack of sufficient food, lack of land, soil infertility, lack of proximal water sources, lack

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[14] Singh, 1990.

[15] Irz, X, et al 2001.

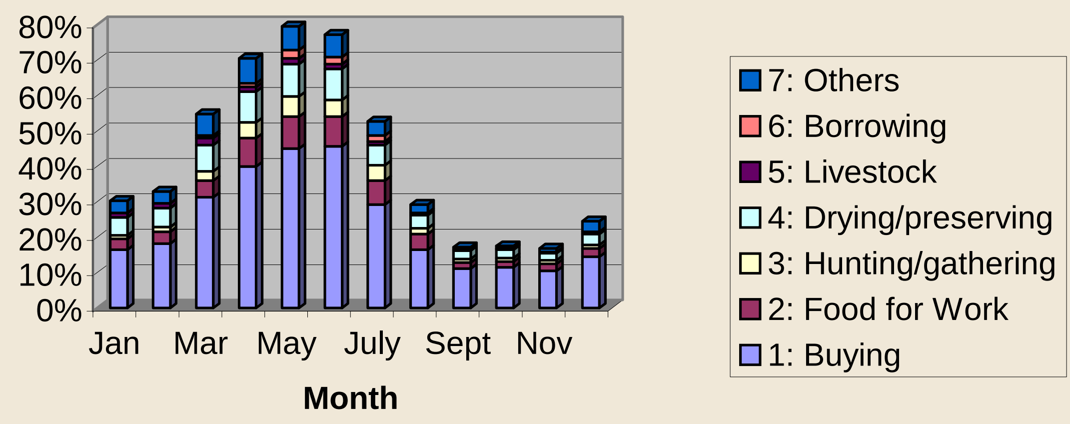
[16] Hunger and food security are discussed fully in DFID's paper on the subject Eliminating Hunger, published May 2002.

[17] Uganda Participatory Poverty Assessment Project (UPPAP) was carried out in 67 communities in 9 pilot districts of Uganda.

of inputs[18], pests and diseases, lack of skills and knowledge[19], lack of capital and access to credit, marketing problems (low prices, lack of markets), poor roads and transport networks, lack of storage and processing, insecurity (primarily Northern and Western Uganda), and loss of oxen due to insecurity and cattle rustling in Northern and Eastern Uganda.

Although the majority of rural households engage in subsistence agriculture, many poor households cannot produce enough food to feed their families. On average in poor rural households who are net buyers of food, these food purchases account for 60% of monthly expenditure (PMA p. 12). This situation may lead to the sale of labor, or forced sale of assets in order to meet household needs. The UPPAP noted a recent trend toward providing casual labour within the home community in return for food or money during times of economic hardship (UPPAP p. 47). In the past, casual labour in the home community was *unheard of* but now local people *resort to* or *are forced to* accept piece-meal work in order to survive because their productivity and their income are insufficient to support their basic needs. Although remuneration in cash or food is often low, irregular and unreliable, casual labour provides an important survival strategy for the poor, particularly during times of economic hardship. This finding was corroborated in this study where food for work was found to form a significant coping strategy during times of shortage. (See Figure 1. below)

Figure 1. Percent of Respondents Who Report Resorting to Each Solution to Food Shortage During Various Months



Casual labouring represents a changing dynamic of local poverty. Casual labour is a survival mechanism employed by those who cannot make a livelihood in another manner. Those who are better off can now afford to hire others who are poorer. While those who are poorer are forced to

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[18] Data from the *Uganda National Household Survey* indicate that in 1995-6, only 1% of LC1s reported the use of improved seeds by poor farmers in the Central region, 8% in the Eastern, and less than 1% in the Northern and the Southern regions. An average of 20% of LC1s reported use of such seeds by better-off farmers in the central, eastern and western regions.

[19] National statistics (*Uganda National Household Survey, 1995-6)* indicate that extension officers only visited 16%, 33%, 9% of LC I areas in the Central, Eastern and Western regions in 1995-96. In the Western region, 45% of the LC I areas received a visit by extension staff.

take piecemeal work in order to survive. The low wages and time taken away from their own agricultural production further perpetuate the cycle of poverty. It is potentially an indicator of the widening the gap between the rich and the poor, even in rural areas.

Several observations from the UPPAP report are particularly relevant to the study area. Insecurity in Northern Uganda and cattle-raiding by the Karimojong in the North East has lead to increasing poverty for communities in the Lake Kyoga Basin.. Loss of oxen in Kumi, Soroti, Lira and Apac has lead to decreasing acreage under cultivation, reduced productivity and food insecurity. “Loss of oxen means that farmers cannot plough. Instead, they resort to using the hand hoe. Thus, the acreage under cultivation is reduced, productivity decreases and food shortages result” (UPPAP, p.161).

The supply of equipment and inputs for farming, is directly related to access to markets. In all rural districts, local farmers and fishermen reported constraints to productivity due to a lack of inputs, ranging from tools to fertilizers, pesticides, spraying equipment and animal drugs. Most of these inputs were not available in nearby markets[20], and where pesticides were availed locally, they often arrived *too late*.

Based on the inter-relatedness of the constraints and opportunities identified by the UPPAP, the Plan for the Modernisation of Agriculture (PMA) recognizes that transformation of the agriculture sector will require a multi-faceted, holistic approach. Constraints to increasing productivity, achieving food security, reduced vulnerability and reducing poverty cannot be addressed in isolation. The PMA recognises that overall poverty reduction must be based on approaches that link agriculture and other sectors - institutionally, organisationally and operationally at all levels from the farmer up to the centre.

The broad strategies outlined in the PMA for reaching these objectives include;

- deepening decentralization to lower levels of local Government for efficient service delivery;
- reducing public sector activities and promoting the role of the private sector;
- supporting the dissemination and adoption of productivity-enhancing technologies;
- guaranteeing food security through the market and improved incomes, thereby allowing households to specialize, rather than through household self-sufficiency;
- enhancing and strengthening stakeholder consultation and participation in the planning and implementation of programs;
- designing and implementing gender-focused and gender-responsive programs; and
- ensuring the co-ordination of the multi-sectoral interventions to remove any constraints to agricultural modernization.

The PMA clearly recognizes that agricultural transformation in the Ugandan context “must start with increased productivity per unit area or animal. Increasing yield per unit of land will require farmers to adopt high yielding, pest- and disease-resistant crop varieties, using proper crop and land husbandry practices, use of organic manure or inorganic fertilizers to maintain soil fertility, in addition to developing skills for sustainable small scale irrigation and water conservation for hedging against drought or poor rains. This will necessitate a new approach to agricultural research and advisory services, which stresses the screening of proven technologies for adoption”

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[20] The *Uganda National Household Survey (1995-6)* indicates that agricultural inputs were available in only 16% of LC I areas nationally. In fact, half of the markets that sell agricultural inputs are located in the trading centres and/or municipalities.

(PMA p. 27). It also requires improved market access for both outputs and inputs. Low productivity in Uganda can be traced to a virtual absence of modern inputs such as improved varieties of crops and livestock breeds, fertilizers, pesticides and irrigation. The low level of input usage can be directly linked to the virtual absence of an efficient distribution network (PMA p. 47).

Unfortunately, while the PMA presents clear ideological precepts for private sector led agricultural development, it is coming under increasing criticism for not offering a clear plan of action for achieving these objectives in the near term. An implementable, results-oriented strategy for facilitating improved access to critical private sector services needs to be put in place soon, before government gets pressured back down the path of government led inefficiency. It is not sufficient to lay the responsibility at the feet of the private sector and expect the problems to be miraculously solved. Critical institutional constraints must be removed. Public goods like market information; agricultural research and agricultural credit can be supplied more efficiently by private sector providers, but will never be profitable in and of themselves. They will require substantial public investment for the indefinite future. They payoff in increased productivity of the agricultural sector, however, makes them a worthwhile public investment.

3.4.2 Summary of Issues and Recommendations

Agricultural productivity must be the engine of growth for Uganda. This requires substantial investment in breaking the critical constraints facing the sector. The worst of the distortions created by price controls and government subsidies for provision of services have been removed. Macro financial policy reform has achieved as much as it can, but the agricultural sector is still beset with inefficiencies resulting from its subsistence roots. Small farmers remain trapped in a vicious cycle of “low input-low output” production. Strategies to facilitate and strengthen private sector led growth need to be developed. It will not happen automatically. Investment in the agricultural sector needs to be increased, but channeled into facilitating services such as rural credit, strengthening of private sector input distribution, providing access to market information, encouraging market linkages, and strengthening of agricultural education. Establishment of the National Agricultural Advisory Service (NAADS), while essential, is only one step in the process.

3.5 Irrigation

The critical triangle recognizes that efforts to protect wild biodiversity must acknowledge the equally pressing need for productive land to produce food, secure rural livelihoods, and contribute to economic development. Between 1950 and 1995, the human population increased by 122 percent while the world’s area planted with grain expanded by only 17 percent. Conversely, grain productivity, increased by 141 percent, largely due to the use of improved varieties and chemical fertilizers. Irrigation has contributed greatly to this higher productivity, with the area under irrigation increasing from about 140 to 270 million ha in the same period (Cohen 1998).

Many crops are highly sensitive to drought stress, while others require a fairly abundant supply of water to grow well. Millions of years ago farmers discovered the advantages of applying supplemental water to crops through irrigation, whether from rivers, lakes, underground aquifers, or artificial tanks. With reliable water supplies, the risk of crop loss is radically reduced and the profit from investment in other agricultural inputs and infrastructure greatly increases. Irrigation is essential to global food supply. Up to 40 percent of the world's crop output comes from irrigated cropland, including nearly two-thirds of the world's rice and wheat production. Globally, intensively managed irrigated croplands account for about 17.5 percent of all cropland. In low- and middle-income countries, an average of 20 percent of arable and perennial cropland is irrigated, reaching 34 percent in East and South Asia. In many Asian countries, millions of ha of roughly contiguous river valleys and floodplains are irrigated, often under smallholder management. Only in Africa has irrigation, been unimportant, comprising only 4 percent of the continent's arable land (Wood, Sebastian, and Scherr 2000).

While the world has enjoyed historically unprecedented increases in agricultural production and productivity since 1950, the critical question is how long that growth can continue and can it keep up with the growing population? Even with the clearing of new agricultural lands, arable land per capita declined from just under 0.5 ha in 1950 to just under 0.3 ha in 1990. Per capita landholdings in developing countries are expected to decline to 0.1–0.2 ha by 2050 (FAO 1993). While, in theory, an additional 1.5–1.7 billion ha could be converted to cropland, the areas with the best cropland are already being fully farmed. Only marginal areas such as tropical forests, infertile soils, steep hillsides, wetlands, and semiarid regions remain for conversion and these areas support a great deal of the world's biodiversity (McNeely and Scherr, 2001).

Some indicators suggest that ecosystem limits are already being over stretched. While irrigation expanded by an average of 2.8 percent per year between 1950 and 1980, subsequent expansion has been much slower, falling to only 1.2 percent per year in the 1990s. On a per capita basis, irrigated lands shrank 6 percent between 1978 and 1990. They are expected to contract by another 12 percent per capita by 2010 as a result of both rapid population growth and inherent constraints in the expansion of irrigated area. Decreased river flows and falling groundwater levels are pervasive in irrigated areas. There are usually few incentives not to overuse water. As a result, most irrigation systems are highly inefficient in their use of water. In the United States, farmers are extracting groundwater faster than the recharge rate on roughly one-fifth of the irrigated area. Even worse, as a result of such inefficient water use, nearly 10 percent of the world's irrigated lands have become so saline as to reduce crop yields, and another 20 percent suffer from a build-up of salts in the soil (Postel 1999).

While rural populations have fallen dramatically in the developed world, in the developing countries, rural populations will continue to remain large. Rural populations in the developing world are projected to peak at 3.09 billion in 2015 (accounting for 94 percent of the world's rural population), then decline over the next 10 years to 3.03 billion (McNeely and Scherr, 2001.) These people will require additional land not only for food and income, but also for settlement and infrastructure. Most will continue to rely on agriculture as their livelihood. Population growth affects poverty, because increasing family size makes economic opportunities harder to find. This in turn leads to exploitation of lower quality agricultural lands and to the breakdown of traditional mechanisms for sustainable resource management.

More than half of the population of Sub-Saharan Africa lives on less than $1 per day. It is the most technologically backward, the most debt distressed, and the most marginalized region in the world (IDE 2002). Yet Africa has some of the most fertile soils in the world. In addition, the climatic conditions can support high-value cultivation. Yet most of Africa's smallholders have not yet been able to grasp the potential opportunities that the sub-continent has to offer. The green revolution, which benefited millions of Asian farmers, has had no effect on African agriculturalists, who still do not have access to the inputs necessary to make the technology succeed.

All across Africa, the rural poor depend more on agriculture than the rural non-poor, and derive more of their income from common property than the non-poor (Scherr 1999b). Because the rural poor have limited access to external or industrial agricultural inputs, "natural capital"—the inherent productivity of their natural resource base, including soils, forests, and water—is of particular importance to their livelihood security. The term "ecological poverty" has recently come into use to describe the type of widespread poverty that arises from degradation or loss of such natural capital (Coward et al. 1999). But ecological poverty both leads to poverty and results from it. When poor people have trouble finding food because of insufficient agricultural production or income, they may become even more dependent on gleaning the products of wild biodiversity, clearing new fields from natural habitat, and poaching and encroaching on protected areas. Such measures may provide emergency relief, but they are not sustainable and may result in significant long-term costs.

While most of Africa's subsistence farmers are trapped in poverty, the success of those few smallholders who have spontaneously adopted irrigation technologies has been largely overlooked. Irrigation planners focus on formal irrigation schemes, without acknowledging the existence of the millions of resource-poor farmers who laboriously carry buckets of water to their fields. These bucket farmers, however, have demonstrated that it is possible to cultivate high-value crops on small plots, and sell them in urban marketplaces. With irrigation devices that are both affordable and appropriate to their scale of investment, hundreds of thousands of these farmers have demonstrated that they can vastly improve on their current circumstances, and gradually reinvest their profits to climb out of poverty.

Over the past 20 years, mounting evidence has shown that access to affordable small-plot irrigation technology for small farmers increases their productivity and income -- providing a powerful poverty alleviation strategy. Over this period, almost a million and a half treadle pumps have been purchased and installed by smallholders in Bangladesh. Costing about $25 each and purchased from local private-sector enterprises, the treadle pumps are helping farmers to generate $130 million dollars a year in new net income (IDE 2002). Since the original program in Bangladesh began 15 years ago, similar private sector based programs have expanded to India, Nepal, Cambodia, and Zambia. Other programs have spread to Mali and Burkina Faso, with the help of the non-governmental organization (NGO) Enterprise Works Worldwide. ApproTEC, a Kenyan-based NGO, has achieved annual sales of more than 6,000 pumps in Kenya, demonstrating that volume sales are possible in Sub-Saharan Africa. (ApproTEC Annual Report).

In the last five years, a second generation of affordable small-plot irrigation technologies has emerged in the form of low-cost sprinkler and drip irrigation systems. More than 25,000 low-cost drip systems have been purchased and installed by small farmers in India, Nepal, China, Sri Lanka, and Kenya (IDE, 2002).

The water resources of Sub-Saharan Africa comprise a major unutilized resource for the region. Only limited developments have occurred along the major rivers. Just an estimated seven percent of the potential irrigable area of the continent has been developed to date and irrigated acreage has been increasing at only an estimated 1 per cent per year. In Kenya, however, where ApproTEC is now selling more than 6,000 pumps per year the resulting expansion of small scale irrigation has resulted in a five percent per annum growth in irrigated area without any major infrastructure development. Similarly, Mali has been the target of an excellent initiative by Enterprise Works to introduce the treadle pump and promote it through mass marketing, selling more than 2,000 pumps per year.

Micro irrigation technologies have been introduced throughout Sub-Saharan Africa, but only three organizations are using a market-driven and commercially oriented approach. This approach is required to penetrate the market and realize the extensive poverty reduction potential that exists from these technologies in combination with other market driven initiatives. The organizations employing this approach are: IDE, ApproTEC, and Enterprise Works (EWW). IDE's programs have focused on Zambia. ApproTEC's approach was developed in Kenya and has now expanded to Tanzania. EWW's programs have focused in West Africa and spread to other central African countries. IDE and ApproTEC have a similar philosophy of dissemination, that is, more centralized manufacturing, with dealerships reaching out to the rural areas, while EWW has tended to focus on smaller multiple manufacturers closer to the farmers. In all cases, the technologies that have been promoted have been a version of the treadle pump, adapted from the models popularized in Asia, with the most common modifications being steel construction and the provision of a pressurized outlet.

At a policy level there are clearly potential trade-offs between economic growth, equity and environmental objectives. Small-scale producers adopting diversified farming systems can prove to be more environmentally friendly than large-scale, intensive production systems based around monoculture. Improvements in productivity by small-scale farmers, linked to more sustainable production systems, can reduce the expansion of cultivation into environmentally sensitive areas such as high forest, wetland or marginal and fragile lands. The challenge is to create the necessary conditions and incentives to increase poor people's access to new technologies and skills for sustainable resource management, with a greater emphasis on participatory technology development and a more significant involvement of the private sector (Harvey, 2002).

3.5.1 Irrigation in Uganda

The Districts of Tororo, Pallisa and Iganga have experienced a dramatic expansion of rice growing in the wetland in the last 20 years. This development was apparently fueled by the collapse of cotton production and the attractive price and ready marketability of rice. It is estimated that about 30% of the population in these districts cultivate rice (25% paddy and 5% upland) (NEMA, 1995). A total of 1,192 sq. km of riverside wetlands (mostly seasonal) have been converted to agriculture. Rice growing occupies 96% of this area, with the balance planted to horticulture, sugar cane and agro-forestry -especially Eucalyptus. (NEMA 1996 p. 5) The swamps used for rice cultivation are inundated during the rains (April to October) and relatively dry during the rest of the year. Most rice producers simply impound rain in bunded fields or rely entirely on seasonal flooding of rivers. Both methods are chancy and result in imperfect water control.

The Kibimba (Iganga) and Doho (Tororo) rice schemes were introduced by government in the 1970's to promote paddy rice production, supported by research and multiplication/dissemination of improved varieties. A spontaneous spread into the seasonal swamps followed during the 1980's, as access to land under controlled irrigation became increasingly inaccessible. By 1992 government rice schemes covered 2,500 ha while farmer led small-scale rice farming is reported to have covered 30,000 ha. During the 1990’s expansion and reclamation were increasing at a rate of 3,200 ha per year (NEMA 1996 p. 20). Observers have noted the drying up of many of the smaller seasonal swamps (which have since been converted back into graze land when they are no longer wet enough to support paddy production). This phenomenon is pushing cultivation deeper into the larger seasonal swamps, where farmers are increasingly using the transplant method so that they can cultivate areas that are too flooded to make broadcasting feasible. The heart of the permanent swamps is not yet cultivated due to the excessive depth of the water.

More recently, the Olweny Swamp Rice Irrigation Project (OSRIP) was established in Lira District, funded by the African Development Bank. It aims at conducting research in rice production, seed multiplication, training of farmers and extension workers on wetland management and carrying out demonstrations on the use of wetlands. They have also carried out work on the short and long-term impacts of land use, rice cultivation and soil management practices on soil properties of various soil types in the wetlands, and have formulated guidelines on the sustainable use of wetlands. (NARO/DFID, 1999.)

In 1996 NEMA conducted a study on the impact of rice production in Tororo and Pallisa. The study noted a worrying trend toward soil acidification and declining yields (with increasing salinity in some areas), increased flooding of roads due to unguided construction of water channels, increased sedimentation of rivers, disruption of the water balance affecting downstream water users, loss of vegetative cover and habitat for rare and endemic species, reduction of diversity of flora and fauna, increased bilharzia and malaria exposure, loss of grazing areas, and loss of organic matter in the soils with continued cultivation. These are the negative impacts of continued rice production.

Concern about soil degradation led NEMA to commission a study of the impact of continuous rice production on soil conditions. To everyone’s surprise, the study concluded that the cultivation of rice does not cause significant changes in the soil PH, contrary to common opinion. Their assessment was that the valley fringes were generally unsuitable for rice production. The widely reported decline in rice yields in the valley bottoms seemed to indicate that continuous monocultural rice production was not sustainable without “significant changes in current technologies and management practices.” They speculated that improved water control and adoption of high yielding production packages could easily double current yields (which average about 1.5 mt/ha of unhusked rice compared to research station small plot trial yields exceeding 7 mt/ha) (Ssali, 1998). Excessive flooding is the major constraint in the permanently water logged swamps, while low organic matter and sandy soil textures are major constraints on the valley fringes. Other constraints to rice production include: lack of improved varieties, poor weed control, bird damage, rodent damage, drought stress, stem borers, rice blast, poor soils and inefficient water management (Tiley, 1970; NARO 1991, Ssali 1998).

Rice production makes a very important contribution to the economy in Pallisa and Tororo and to the livelihoods of thousands of small farmers. It is politically impossible at this time to ban paddy rice production, or to reverse the impact such production has had on the seasonal swamps of the area. The challenge is to learn valuable lessons from this uncontrolled expansion that will allow other wetland communities to capture the potential benefits of more intensive irrigated agriculture, without suffering the wetland degradation and loss of biodiversity that resulted in Kumi and Pallisa. Recommended mitigation practices (NEMA 1996) include:

- Leave a 10-meter wide strip of uncultivated land along river and main water courses as a conservation of habitat and sedimentation barrier.

- Leave as much natural vegetation in and around the fields as possible. (Note this recommendation is particularly challenging, due to the threat of cereal eating birds destroying the crops.)
- Natural wetlands to be left between the rice fields to cater for endangered fauns and preserve vegetation important to the community for building materials and crafts.
- Limit use of chemical controls to avoid pollution and poisoning of wildlife.
- Confine rice cultivation to wetland fringes (e.g. harvesting water for release in to the rice fields leaving the main water system intact for fish habitat.)
- Promote runoff water harvesting techniques and simple treadle pumps for watering of upland varieties to reduce swamp pressure.
- Promote research and dissemination on upland rice varieties as an alternative.

3.5.2 Summary of Issues and Recommendations

Because of the current low level of irrigation, Africa is in the enviable position of being able to learn from the rest of the world's mistakes in forging its irrigation policies. Some of these important lessons include:

- Large scale subsidized irrigation schemes are management intensive and often uneconomical. They have usually created the wrong incentive structures for water control and management resulting in lowered water tables, salinization of extensive areas, and poor track records for maintenance and sustainability.
- Individual initiative will continue to push the margins of irrigated agriculture to respond to the urgent food needs of a growing population. Wetland protection policies must be structured in such a manner as to encourage best practices, rather than simply stopping production. The current ban on cultivation within 100 meters of a major water body is unrealistic and makes small-scale irrigation too expensive to serve the needs of the small producers who are potentially the most ecologically friendly water users.
- It is urgent that we introduce the right incentives to limit over-use of water to prevent lowered water tables, and expanding salization.
- There is tremendous potential for adaptation of low-cost small-scale technologies perfected in Asia (treadle pumps and drip irrigation systems), which are more environmentally friendly and economically suited for the transition from subsistence to small-scale commercial production.
- Commercially oriented distribution systems for low cost technologies need to initially be facilitated and supported to grow to an economically viable scale of operation, but once established, they can then achieve financial sustainability.
- Pressures for expanded irrigated acreage need to be channeled in the right direction by a combination of "push" and "pull" incentives. Pushing farmers out of fragile and unsuited environments through appropriately formulated community controls on wetland drainage and cultivation, and pulling them into more sustainable fringe cultivation with the availability of appropriate low cost technologies for water delivery, soil fertility management and improved upland varieties.

4.0 RESEARCH METHODOLOGY

The breadth of the research questions being addressed to explore the relationships among the three elements of the critical triangle, required utilization of a range of research techniques to capture the necessary information in the most reliable but cost-effective manner. The methodology, therefore, included a combination of Rapid Appraisal techniques and survey interviews to capture information at both the community and the household level. Primary data collection was supplemented with an extensive literature search.

4.1 Study Area

The study area comprised the Lake Kyoga and Lake Kwania catchments area. This important wetland resource is located within the dry belt of Uganda (sometimes referred to as the "cattle corridor") that stretches from Mbarara in the Southwest to Karamoja in the Northeast. Despite the low average rainfall (500 mm/annum) this area is characterized by farming systems which are primarily based on annual crops. The rain-shadow along the lakeshore makes rain-fed agriculture exceedingly risky.

4.2 Research Methods

The research methodology included:

- Systematic sampling of the sub counties surrounding the lake. A total of 21 sub counties were sampled, beginning with Masindi Port and alternating as one proceeded around the lake.
- Community focus group discussions using Rapid Appraisal (RA) tools were used to develop a systematic picture of the trends in utilization and to categorize the types of utilization.
- Development of the sample frame and selection of respondents was done during the community meeting. This transparency was intended to solicit maximum co-operation and reduce misunderstanding and suspicion that might arise, given the sensitive nature of the question of wetlands utilization.
- Individual interviews were then conducted with randomly selected representatives of the various user categories, to estimate parameters for each user type.

The senior researchers supervised the data collection. Community sessions were staggered to allow personal facilitation by the senior researchers with the assistance of experienced research assistants drawn from Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and Makerere University, Kampala. Translation services and local context for the RA exercise was provided by the participation of the Sub county level extension staff and the District Environment Officer. The research assistants and extension staff conducted survey data collection, after extensive training and field-testing under senior researcher supervision. The target was to complete a minimum of 12 (maximum of 16) individual household surveys in each of the 21 selected communities. Data collection failed in one Sub county, resulting in a total of 20 PRA meetings. A total of 298 household surveys were conducted in these 20 communities (an average of 14 or 15 per Sub-county).

The study sought to triangulate information collected by means of the detailed household survey with community level data collected using PRA methodologies. A set of standardized PRA tools was implemented in each community meeting. The tools used were a derivative of the approach developed by the IUCN for assessing rural sustainability (IUCN 1997). A copy of the PRA data collection instrument is attached in Appendix 3. The PRA process involved establishment of a common understanding of the natural resource base for the community by means of discussion and mapping, and various exercises to quantify trends in the availability, quality, and utilization of those resources - with a particular emphasis on aspects related to wetlands and agricultural production. Additional trends for population growth and composition, wealth, and sources of income were also explored. For purposes of trend analysis, attempts were made to quantify all aspects at two different time periods, the present (2001) and approximately 20 years ago. (Because of the significant events surrounding the overthrow of Idi Amin's government in 1980, this proved an easy mental marker for people to tie comparisons to.) Standardization of the data collection process and reporting format allowed for simple trend analysis across the 20 locations using non-parametric statistical procedures.

The process, however, did suffer from a certain lack of uniformity. The element of variability was due to the use of 6 different teams of research assistants employed to cope with the logistical constraints of completing both the community meetings and the household surveys in a limited time, as well as the high degree of cultural and language differences in the Lake Kyoga basin[21]. While every attempt was made to standardize approaches by means of training and pretesting, a degree of variation in application of the tools was observed. The topic most affected by this variability was the attempt to measure trends in the biodiversity of the local wetland. The number of species identified by the community participants depended more on the thoroughness and language skills of the facilitator, than on the actual diversity of the local environment. This problem seriously frustrated efforts to use this data to develop an index of local biodiversity. A thorough search of the secondary literature to find suitable data on biodiversity also proved fruitless. As a result, it became necessary to use an index of diversity of wetlands utilization to capture the element of environmental diversity in the critical triangle, rather than an index of biodiversity, which would have been a community level variable rather than a household level variable.

Data analysis was done using a statistical package called Inter-cooled Stata (version 6.0). Analysis included generation of descriptive statistics, non-parametric analysis of the significance of trend rankings, regression analysis of the determinants of productivity, and development of Ordered Probit models to analyze the determinants of wetland diversity and food security.

5.0 DATA PRESENTATION AND INTERPRETATION

This chapter presents findings in reference to the research questions as previously presented in section one.

- What are the characteristics of the alternative forms of wetland utilization? What is the demand for the respective types of wetland utilization and what is the economic contribution of each? How has this changed over time?

[21] The research teams were formed around three major language groups (Luo, Ateso and Luganda) although local language differences resulted in some meetings needing to be conducted in either English or Swahili, with translation assistance provided by local extension staff or community leaders.

- What is the current extent of wetland utilization for agricultural purposes, and what has been the historical trend?
- What is the food security situation in the Lake Kyoga basin? What are the factors that influence its distribution among households? How has this changed over time?
- What are the determinants of agricultural productivity and how does this relate to food security and wetlands utilization?

The findings were obtained from the two primary sources of data, the community level PRA exercises and the household level survey data. Results are presented in tables and figures, showing relevant frequencies, percentages and chi-square tests.

The chapter is divided into two sections. The first section presents the descriptive and trend characteristics of the study sample, at both the community and household level. The second section discusses econometric findings on the relationships between the three principle independent variables (Wetland Diversity, Food Security and Productivity) and their respective dependent variables.

5.1 Descriptive Statistics Regarding Wetland Utilization and Historical Trends

Both the PRA and the household survey generated a wealth of information about the manner in which communities and households perceive the benefits they receive from living in an area blessed with wetlands. The PRA was specifically structured to solicit community perceptions of the changes in utilization of natural resources in the last twenty years and the resulting impact on incomes and food security.

5.2.1 Wetland Access and Uses

The vast majority of households in the selected communities had access to wetland resources. As shown in the following table. This is to be expected; since the selection of communities was based on visual inspection of the NEMA maps to pick communities in each Sub county that were in close proximity to significant wetlands.

Table 1. WETLAND ACCESS AND USES	**Number**	**%**
Have Access to swamps that they either "own" or which are common property resources adjacent to their land.	277	94%
Collect fuel wood from the Swamp	195	66%
Use the swamp for hunting	40	14%
Use the swamp for fishing	140	48%
Use the swamp for grazing livestock	113	38%
Use the swamp for agriculture (either through irrigation of by cultivating in the swamp fringes)	62	21%
Collect building or craft materials from the swamp	223	76%
Collect water for household use from the swamp.	62	21%

The PRA exercise included preparation of an participatory map of the community. Using this to establish a common understanding of the resource base for the community, a ranking exercise was used to estimate the proportion of land occupied by various resources. This allocation was then compared to the resource allocation in1981. The data was then subjected to the Wilcox Sign-Rank test to determine whether there were significant trends across all 22 communities. The results are shown in the table below.

Table 2. Test of Significance for Trends in Natural Resource Area

Area	Now	Past	Sign Rank Test	Significance
Lake	19%	15%	z = 1.481	Prob > |z| = 0.1386
Swamp	10%	12%	z = -1.287	Prob > |z| = 0.1980
Trees	14%	19%	z = -2.879	Prob > |z| = 0.0040
Farm Land	32%	29%	z = 0.915	Prob > |z| = 0.3600
Graze Land	13%	11%	z = 1.363	Prob > |z| = 0.1730
Rocks	5%	5%	Not tested – too few observations	
Other	8%	9%		
	100%	100%		

The only significant trend that was observed across the entire sample is the decline in forested area due to over utilization. Clearly this trend is resulting in reduced habitat for wildlife and a resulting loss in bio-diversity as seen later in the decline in hunting in all communities. The community members were then asked to define what they thought were the important elements of "QUALITY" for each of the natural resources and then to rank them against this definition of quality on a scale of 0 to 5, with zero being the worst, and 5 being the best.

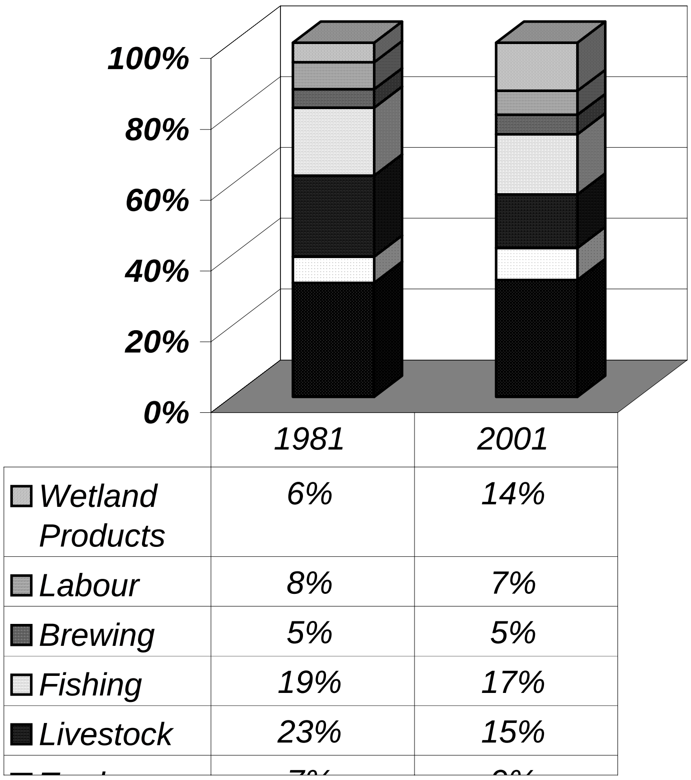
Quality	Now	Past	Sign Rank Test	Significance
Lake	2.56	4.44	z = -3.292	Prob > |z| = 0.0010
Swamp	2.65	3.76	z = -1.964	Prob > |z| = 0.0496
Trees/Forests	1.94	4.29	Z = -3.041	Prob > |z| = 0.0024
Farm Land	2.41	4.24	z = -2.995	Prob > |z| = 0.0027
Graze Land	2.86	4.14	z = -2.256	Prob > |z| = 0.0241
Rocks	3.00	2.50	Not tested – too few observations	

The perception of reduction in quality of the natural resources is significant at the 5% level for swamp and grazing resources and at the 1% level for lake, forests, and farming land. Clearly there is a common perception that natural resource quality has deteriorated significantly in the entire study area over the last 20 years.

5.2.2 Trends in Income Sources

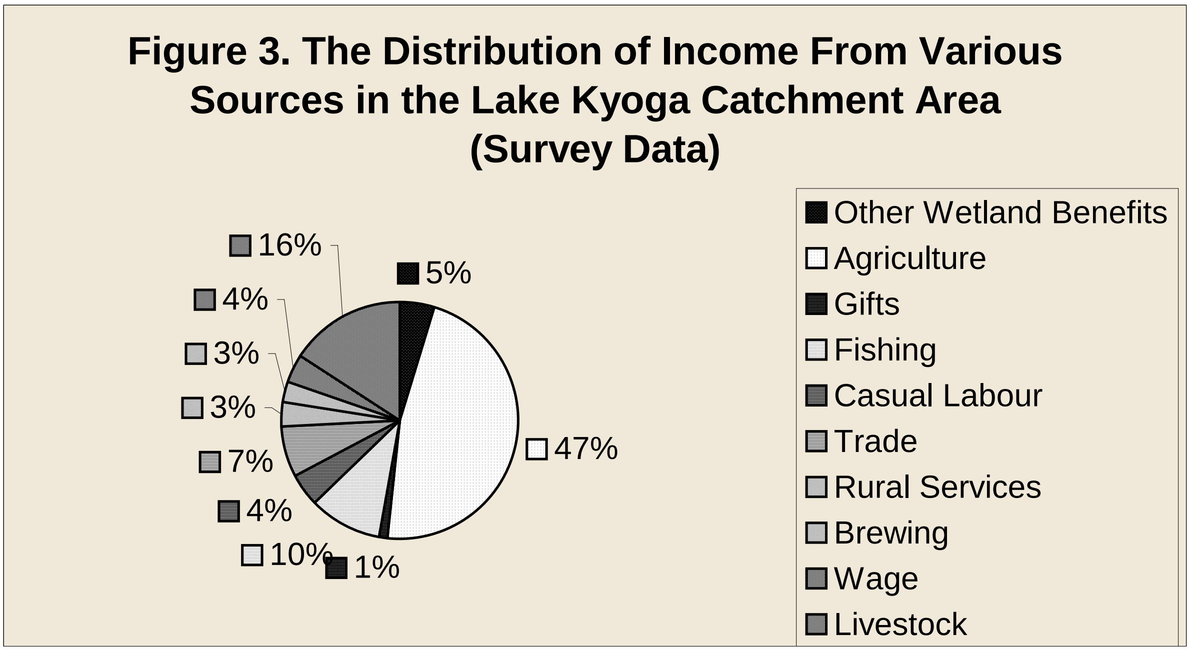
To capture the trends in sources of income, communities were asked to identify the proportion of the households involved in various types of income generation, now and in the past. The results across all communities are presented in the following figure.

Figure 2. Changes in Sources of Community Income

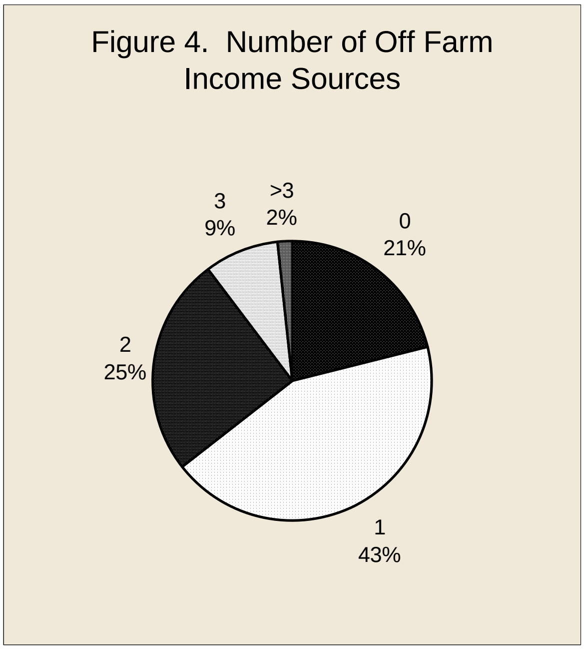


The perceived increase in trade is significant at the 5% level while the increase in income contributed by wetland products is significant at 1% level. Sign rank test on other trend variables was not significantly different than what might have been expected by chance. The fairly large change in livestock incomes is affected by heavy reduction in livestock numbers in eight of the districts due to insecurity and cattle raiding in the last 15 years, but proves not to be significant because four of the districts further south have experienced increases in the contribution of livestock to community incomes over the same period. Thus the trend for the lake catchment as a whole is not clearly significant.

The PRA approach had one drawback, in that it did not allow for multiple income sources per household, but rather revealed the overall trends for the community as a whole. This can be compared to the household level data presented in the figures on the following page.



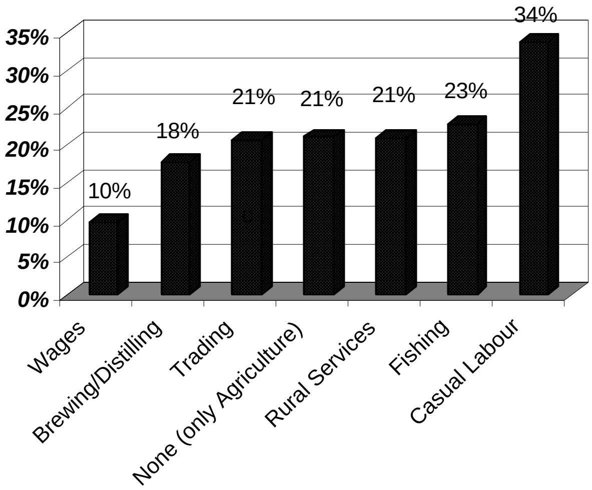
When wetlands contribution to agriculture, livestock and fishing was separated out (to avoid double counting of earnings) the proportion of income from wetlands benefits fell to 5%. Agriculture remains the largest contributor at 47%. Followed by livestock at 16% and fishing at 10%. Trade contributed 7% of the income in these communities.



The survey data revealed that the majority of households had recourse to more than one source of income. Only 21% of households were entirely dependent on agriculture. 43% had one additional source of off-farm income, while 36% had two or more sources of off-farm income.

As seen in the figure on the next page, the most common source of additional income was casual labour, with 34% of households engaged in sale of labour (either for cash or for food) during the year. This was followed in almost equal proportions by fishing, sale of services, and rural trade with brewing and distilling following very closely. Wage earners clearly formed a distinct minority, with only 10% of households having a wage earner in the family.

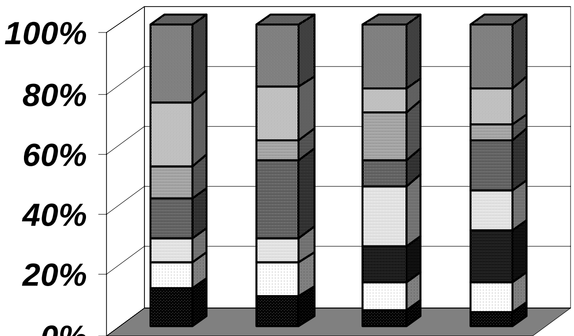
Figure 5. Proportion of Households Earning Non-Farm Income by Source (From Household Survey Data)



5.2.3 Trends in Food Consumption Patterns

The next area of analysis was changes in food consumption patterns over time, with particular emphasis on coping mechanisms for dealing with periods of food shortage. The food consumption trend patterns are illustrated in the figure below.

Figure 6. Changes in Food Consumption Patterns During Times of Abundance and Shortage



	Abundance 2001	Abundance 1981	Shortage 2001	Shortage 1981
Cassava	25%	21%	21%	21%
SweetPotato	21%	17%	7%	12%
Maize	11%	7%	16%	5%
Millet	13%	26%	9%	17%
Sorghum	8%	8%	20%	13%
Wild	0%	0%	12%	17%
Legumes	9%	11%	9%	10%

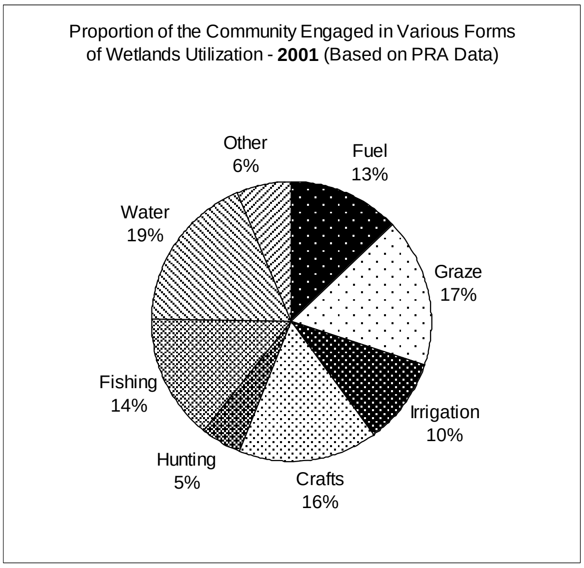
Changes in consumption of millet (declining) and maize (increasing) during times of abundance are both significant at the 1% level. With respect to trends in consumption during times of shortage, the change in sorghum (rising) and sweet potatoe (declining) is significant at the 5% level while the increase in consumption of maize is significant at the 1% level. The increase in maize consumption is primarily a result of increased dependence on purchased foods during times of shortage, rather than a major trend towards increased local production. This illustrates the increased interdependence of the communities and the reliance on income generation to meet short-term subsistence shortfalls.

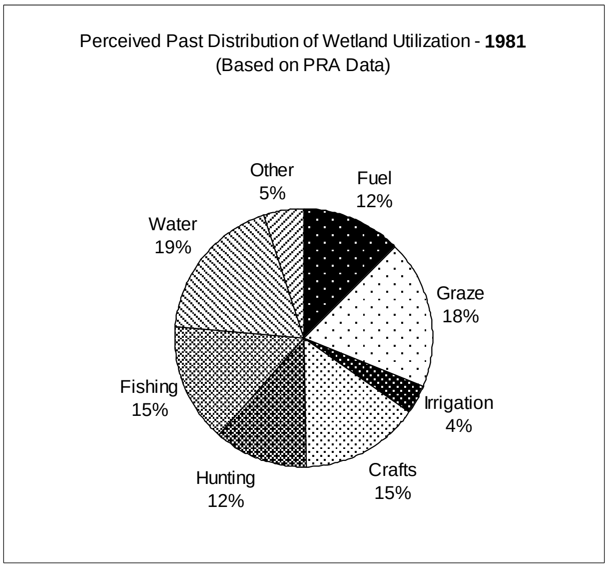
While the reduction in consumption of wild foods looks large, it proved not to be significant because ten out of the 18 observations showed zero difference. The apparent trend is resulting from fairly large differences in less than half of the observations.

5.2.4 Trends in Wetlands Utilization and the Economic Valuation of Natural Resource Use

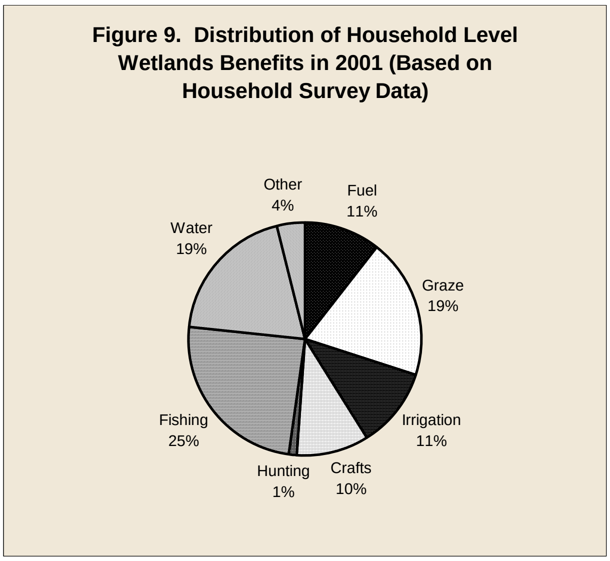
The next area of analysis was that of wetlands utilization and the economic benefits thereof. These trends are presented in the figures below. In addition to the findings themselves, this area generated interesting methodological insights as well.

Figures 7 and 8.





Trend patterns regarding change in wetlands utilization are only significant for hunting (significantly negative at 5% level) and irrigation (significantly positive at 1% level).



It is very interesting to note, however, the striking similarity in results between the PRA data and the household level survey data, which is based on estimates of household incomes earned from various types of uses. While the household level estimate of value of craft and building materials is quite a bit less than those from the PRA estimates of current benefit, and the household estimate of fishing income is quite a bit higher, the rest of the use estimates are remarkably consistent. This congruence of findings helps to strengthen our confidence in both the approach and the results.

In a similar manner, the value of wetlands utilization was estimated in the household surveys using two different approaches. In the first, the respondent compared the annual benefits from each of the different forms of wetlands utilization to the value of a bicycle, (something the majority of rural households were familiar with). In the second approach, the value of each form of wetlands utilization was calculated separately by working up from the number of times used in a year, multiplied by the value per time to get a shilling estimate of the total annual value. (For example, the estimation of the value of fuel wood collected from the swamp was calculated from two questions. First, "How many days per year do you collect firewood from the swamp"? Secondly, "What is the value of firewood you collect each day?") The figures depicting estimated average value of swamp utilization per household using each of the two methods is show in the figures on the following page. The results from the two approaches are remarkably similar. The major differences are in income from fishing, which tended to be under estimated using the bicycle method, and value of swamp water for irrigation, which may have been undercounted when the revenue from all of the agricultural production activities was being itemized. The survey asked farmers to indicate whether the field was rain fed, irrigated or cultivated in the swamp, but in many cases this particular question was not answered. Farmers may have been reluctant to admit the extent to which they are cultivating in the swamps fearing restrictions from NEMA.

Figure 10.

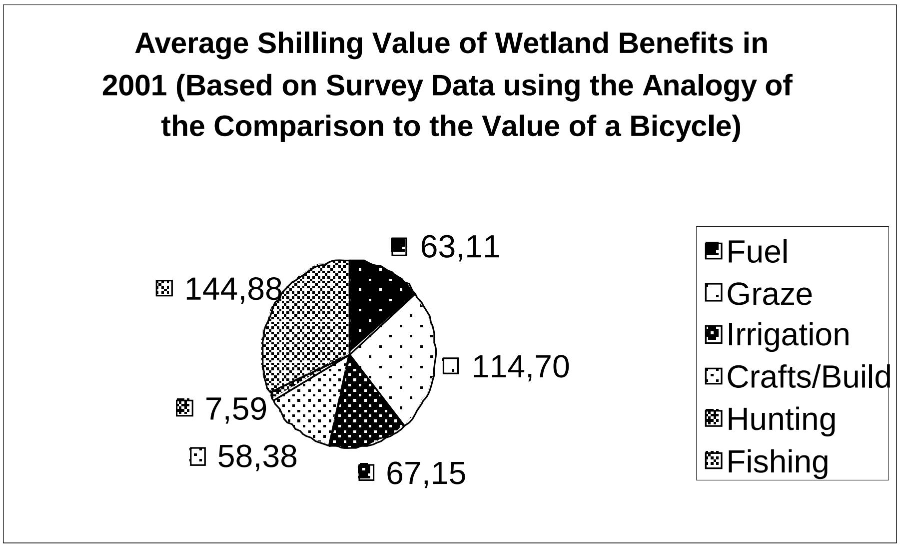
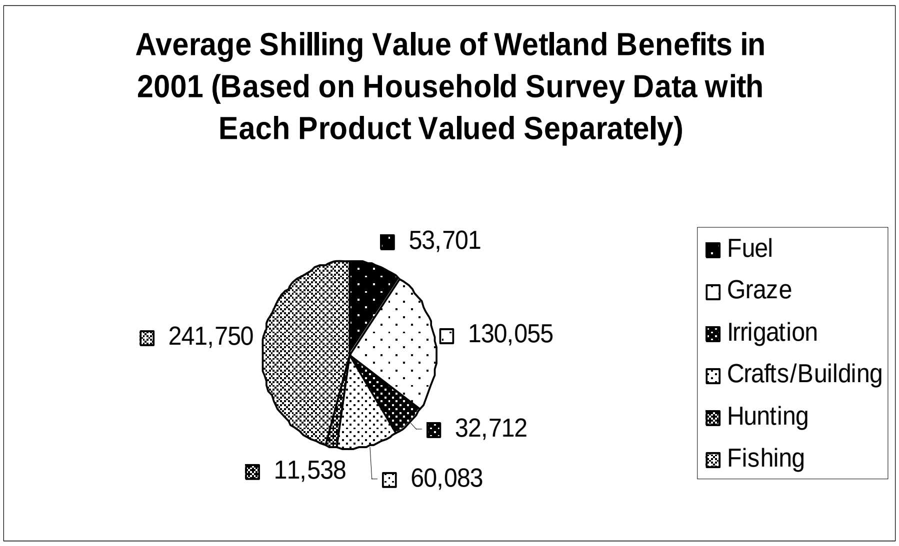


Figure 11.



5.2.5. Characteristics of the Household Sample With Respect to Diversity of Wetlands Utilization and Food Security

As mentioned previously, household level indices were created for Diversity of Wetlands Utilization (WDI) and for Food Security (FSI). The Food Security index was based on the following three survey questions.

How many meals do you usually eat every day?	37 1= One, 2=Two, 3=Three, 4=Three plus tea
How frequently does your family get animal protein? (E.g. meat, milk eggs)	42, 1=special occasions only 2=At least once a month, 3=At least once a week, 4= Daily?
How frequently do you experience staple food shortages?	43 1=Food is never enough, 2=Every season, 3= At least once every year, 4= Only in bad years, 5=Never

The responses from the three questions were summed, resulting in an index with possible answers ranging from 3 to 13. These answers were then clustered into an index with four possible values.

3 - 6=1
7 - 8=2
9 - 10=3
11-13=4

Distributed in the following manner

FSI	Frequency	Percent	Cumulative Percent
1	37	13.45	13.45
2	96	34.91	48.36
3	115	41.82	90.18
4	27	9.82	100.00
Total	275	100.00	

The distribution of the food security index varied significantly, however, between districts within the study area, with Kumi, Kaberamaido, Soroti and Masindi being the most food secure and Kayunga, Apac and Lira being the most insecure.

	FSI – Percentage by District				
District	1	2	3	4	Total
Apac	25.81	38.71	32.26	3.23	100
Kaberamaido	6.25	31.25	43.75	18.75	100
Kamuli	14.29	46.43	35.71	3.57	100
Kayunga	46.15	15.38	23.08	15.38	100
Kumi	7.69	19.23	46.15	26.92	100
Lira	19.61	49.02	31.37	0	100
Masindi	0	21.43	64.29	14.29	100
Nakasongola	4.17	37.5	45.83	12.5	100
Pallisa	10.53	36.84	47.37	5.26	100
Soroti	5.66	28.3	52.83	13.21	100
Total	14.016	32.409	42.264	11.311	100

Pearson chi2(27) = 56.7354 Pr = 0.001
Likelihood-ratio chi2 (27) = .
Cramer's V = 0.2622
gamma = 0.1763 ASE = 0.061
Kendall's tau-b = 0.1368 ASE = 0.047

In a comparable manner an index for diversity of wetland utilization was created for each household based on the number of various uses to which the household derived from the wetlands. Options included irrigation, hunting, fishing, fuel wood and building/craft material collection. (Since virtually every household collected water from the wetland for household use, water collection was not considered a separate use.) The potential range of values is from zero to four where four equals four or more uses.

The Distribution of the WDI across districts is shown in the table below. Clearly there were significant differences in distribution across locations, with Nakasongola, Kaberamaido and Kayunga exhibiting the least diversity of use and Kumi, Pallisa and Soroti exhibiting the most.

Table 3. Distribution of Wetlands Utilization by District

	WDI						
District	0	1	2	3	4	Total	Average
Apac	6.06	9.09	24.24	18.18	42.42	100	2.8179
Kaberamaido	6.25	12.5	25	31.25	25	100	2.5625
Kamuli	6.9	10.34	17.24	20.69	44.83	100	2.8621
Kayunga	0	31.25	43.75	6.25	18.75	100	2.125
Kumi	0	3.7	22.22	14.81	59.26	100	3.2961
Lira	1.72	6.9	25.86	24.14	41.38	100	2.9656
Masindi	0	6.25	37.5	25	31.25	100	2.8125
Nakasongola	12.5	37.5	8.33	33.33	8.33	100	1.8747
Pallisa	0	9.09	9.09	36.36	45.45	100	3.1815
Soroti	1.75	10.53	5.26	42.11	40.35	100	3.0878
Total	3.68	12.04	19.4	26.76	38.13	100	2.8364

Pearson chi2(40) = 100.9866 Pr = 0.000
Likelihood-ratio chi2 (40) = .
Cramer's V = 0.2906
gamma = 0.0523 ASE = 0.057
Kendall's tau-b = 0.0422 ASE = 0.046

5.2 Econometric Analysis

The econometric analysis focused on the household level determinants of wetland diversity, food security and the productivity of the different crop enterprises. For the Wetland Diversity and Food security econometric regressions each had an ordinal dependent variable created as described above.

We used a maximum likelihood ordered probit regression for the Wetland Diversity and Food Security analysis, as the use of least square estimation procedures would give inconsistent and biased estimates. The use of ordered probit or ordered logit maximum models is the most appropriate statistical methods for such ordered response data (Amemiya 1985).

The econometric models for the Wetland Diversity and Food Security regressions were specified as:

a). $WDI^h = a_i + \sum b_i\, dist_i^h + \sum c_i\, bev_i^h + u_i$, $u_i \sim N(0, \sigma u^2)$

b). $FSI^h = e_i + \sum p_i\, dist_i^h + \sum f_i\, bev_i^h + \sum g_i\, hc_i^h + v_i$, $v_i \sim \sqrt{}N(0, \sigma u^2)$

Where; WDI^h = Wetland Diversity Index of household h
FSI^h = Food Security Index of household h
$dist_i^h$ = a vector of the district dummies
bev_i^h = a vector of Incomes derived from the wetland
hc_i = a vector of household characteristics.
$u_i v_i$ =error terms assumed to be normally distributed with mean 0 and constant variance
a_i b_i c_i d_i p_i f_i g_i = Parameters estimated using maximum likelihood estimate method.

In addition, in order to improve our understanding of the determinants of productivity, generalized least square regressions were run to estimate the determinants of the value of crop production per acre for each of the major crops produced in the study area including; cassava, sweet potatoes, groundnuts, millet, sorghum, maize, beans and simsim. The least square regression for each crop was specified as.

$Inc^h_{ci} = K_{ci} + \sum M_{ic}\, dirt_i^h + \sum L_c i\, ss_i^h + n_c iLab + Zci\ Invest + ui \sim N(0, \sigma u^2)$

Where;
Inc^h_{ci} = Income per acre derived from crop type ii for household h
$\sum dirt_i^h$ = Vector of district dummies
$\sum ss_i^h$ = Vector of Seasons
Lab = availability of family labour for production
Invest = the investment in productive inputs for that crop

$K_c i$ $m_c i$ $h_c i$ $n_c i$ $r_c i$ $z_c i$ are parameters to be estimated using least squares estimation method for the different crops.

5.2.1 Econometric Diagnostic Tests and Specifications

All the regressions had potential estimation problems. This being cross-sectional data, it was highly suspect with respect to hetero-skedasticity. We tested for hetero-skedasticity using the Cooks and Weisberg (1983) test which showed its presence in all the regressions. This problem was corrected using the White-Huber sandwich estimator as implemented by Stata version 7.0 that uses standard errors that are robust to hetero-skedasticity.

Since the regressions had many explanatory variables, multi-collinearity could not be ruled out. This was investigated using the variance inflation factor method (Chatterjee and Price 1991). Since the maximum VIF was less than 3, we found that multi-collinearity was not a serious problem.

We tested for normality of the error term using the Jargue Bera Langrage multiplier test of skewness and kurtosis, as well as using the Shapiro Wilk and Shapiro Francia tests of normality. The tests revealed that the variables of crop value, acreage, and off-farm income were not normally distributed. Using the Box Cox power of transformation, the log transformation was identified as the most appropriate transformation of the variables to normality.
We examined the appropriate mathematical functional forms (non-linearity and interaction terms in the data) of the variables in the regressions. Using the exploratory band regression method (Linear spine method), the variables of fishv (value of wetland fishing), buildv (value of wetland building material collection), fuelv (value of wetland fuel collection) and totlvsin (total livestock income), showed a non-linear relationship with the dependant variables, hence their quadratic functional form was included in the models, which greatly improved model specification. The Ramsey regression error specification test (REST) for omitted variable bias could not be performed, as it is invalid for ordered probit models, however the Hosmer-Lemeshow goodness fit test showed that the models are generally good fits. We did not suspect Endogenity bias problems in all these regressions hence we did not perform the Hausman-Wu specification tests. All these tests were performed using Stata version 7.0.

5.2.2 Determinants Of Wetland Diversity And Food Security

The results of the econometric analysis for Wetland Diversity and Food Security are presented in the following table**.**

Table 4. Ordered Probit Maximum Likelihood Estimates

Independent Variable	Wetland Diversity Index	Food Security Index
Wetland Diversity Index Dummy		-0.166
Food Security Dummy	0.173	-
District Dummies[22]		
Apac	0.618	0.342
Kamuli	1.013*	-0.010
Kayunga	1.137*	-0.041
Kumi	2.012***	0.286
Lira	1.708***	-0.136
Masindi	1.230**	0.279
Nakasongola	0.533	-0.081
Pallisa	1.468***	-0.237
Soroti	1.546***	0.445
Swamp access	0.452**	-
Value of hunted products	29.9*	-
Value of Fish products	1.683***	0.522***
Value of Fuel products	7.742***	-
Value of Fuel products squared	-8.806***	-
Value of building products	6.577***	-
Value of building products squared	-2.127***	-
Value of Livestock	2.284***	0.010
Value of Livestock squared	-0.815***	-
Availability of family labour (Number of workers in the family)	-	0.002
Value of Crop products	-	0.074
Irrigated Agriculture	1.560***	0.555**
Log of Farm size	-	0.395***
Value of gifts	-	0.563**
Trading	-	0.198
Log of non-farm Income	-	0.252**
Dependency ratio	-	-0.067
Sex of household head	-	-0.131
Vulnerability	-	-10.300***
Number of observations	209	187
Log likelihood	-185.894	-177.962
Wald Chi-square	242.63***	2613.88***
Pseudo R2	0.3712	0.2025

NOTE: ***, **, * means the coefficient is statistically significant at 1%, 5%, and 10% levels respectively.

As shown by the regression results, Wetland Diversity shows a significant positive association with access to swamp land, hunting and fishing activities, fuel collection, livestock income, and irrigation. The presence of positive levels of these activities increases the diversity of wetland

[22] Note Kaberamaido is not included and hence forms the base of comparison for the other Districts.

utilization for the household. However, extraction of fuel products, building products, and livestock grazing were shown to have non-linear relationships with wetland diversity. Their respective squared variables all have significant negative coefficients, which show that at a certain higher level of involvement, extraction of fuel and building/craft products or livestock grazing becomes the major household activity to the exclusion of others, reducing the diversity of wetland uses by the household.

For the Food Security Index, the analysis shows that value of fish products, log of farm size, and log of non-farm income were all positive and significant at the 1% level while presence of irrigation, and value of gifts were positive and significant at the 5% level. The strongest variable by far, however, proved to be that of "vulnerability" which displays a strongly negative coefficient. The vulnerability of a household was determined by the absence of adult family members as potential income earners.

5.2.3 Determinants of Productivity

The detailed results of the generalized least squares analysis of the determinants of productivity per acre for each of the major crops in the study area is presented in the tables in Appendix 5. Eight equations were estimated – one for each of the major crops produced in the study area. The variables used were the same for all of the equations. The table below summarizes the significance of the various coefficients for each variable in each of these eight equations**.**

Table 5. Determinants of Productivity by Crop

Note: some variables dropped due to multicollinearity where there were very few observations.

	Cassava		Sw. Potato		Groundnuts		Millet		Sorghum		Maize		Beans		Simsim	
	sign	signif	sign	signif	sign	signif	sign	signif	sign	signif	sign	Signif	sign	signif	sign	signif
1st season	+	NS	-	***	+	***	-	**	+	***		Dropped	+	NS	+	***
2nd season	-	***	-	***		dropped	-	***	+	***	-	***		dropped		dropped
Dry season	-	NS	-	***		dropped	-	NS		dropped		dropped		dropped		dropped
irrigated	+	***	+	***		dropped		dropped	+	NS	+	***	+	NS		dropped
logacres	-	***	-	***	-	***	-	***	-	***	-	NS	-	***	-	NS
Family labour	+	***	+	**	-	NS	-	***	-	***	+	***	-	***	+	***
Labour2	-	***	-	**	+	**	+	***	+	***	-	***	+	***	-	**
Investment	+	***	+	***	+	NS	+	***	+	***	+	**	+	***	+	***
Apac	+	***	-	***		dropped		dropped		dropped	-	***	-	*	+	***
Kamuli	-	***	-	**		dropped	-	***		dropped	-	***		dropped		dropped
Kayunga	-	***	-	***		dropped	-	***		dropped	-	***		dropped		dropped
Kumi	+	***	-	***	+	**	-	***	+	***	+	***	+	NS		dropped
Lira	+	NS	-	***	+	NS	-	***	+	***	-	*	-	**	+	NS
Masindi	+	***	+	NS	+	NS		dropped	+	***	-	***	-	NS		dropped
Nakasongola	-	NS	+	NS	+	***	-	***		dropped	-	***	-	***		dropped
Pallisa	-	***	-	***	-	NS	-	NS	-	NS	-	***	-	**		dropped
Soroti	+	***	-	**	+	NS	-	***	+	NS	-	***	-	NS	-	NS
_constant	+	***	+	***	+	***	+	***	+	dropped	+	***	+	***	+	***

Kaberamaido is the basis for comparison for the district dummies
Perrennial or no specified season is the basis for comparison for the seasonal dummies

The results of the productivity analysis show a considerable consistency. All of the equations were well defined. Location, seasonality, investment in agricultural production inputs and use of irrigation were all significant determinants of productivity. Interestingly, the larger the size of the plot, the lower the productivity when other factors like District, season and investment in inputs are held constant. The relationship between productivity and family labour availability was inconsistent between crops.

5.2.4 Inferential Statistics

A Pearson's correlation matrix was run in order to analyze the relationship between food security, productivity and wetlands utilization. The results are shown in Table 6 below.

Table 6. Pearson Correlation Matrix

		Food Security Index	Wetland Utilization Dummy	Ln productivity	Ln value of crop production	Ln Off-farm income
Food Security Index	correlation	1				
	Significance					
	observations	275				
Wetland Utilization Dummy	correlation	0.1099	1			
	Significance	0.0688				
	observations	275	299			
Ln productivity	correlation	0.1785*	0.1274*	1		
	Significance	0.0064	0.0441			
	observations	232	250	250		
Ln value of crop production	correlation	0.3349*	0.1590*	0.8854*	1	
	Significance	0	0.0118	0		
	observations	232	250	250	250	
Ln Off-farm income	correlation	0.1047	0.1658*	0.0896	0.1419*	1
	Significance	0.1216	0.0109	0.2059	0.0445	
	observations	220	235	201	201	235

Source: Primary Data

The correlation analysis shows a weakly significant positive relationships between Food Security and Diversity of Wetland Utilization (r=0.11*,p-value<0.01). The relationship between Productivity and both Food security and Wetland Utilization, however, is significant at the 5% level as is the correlation between Food Security and Wetlands Utilization with the total value of household crop production and that between Wetlands Utilization and off-farm income.

6.0 DISCUSSION AND RECOMMENDATIONS:

6.1 Discussion

6.1.1 Historical Trends in Food Security, Wetlands Utilization and Productivity

The PRA exercise clearly illustrated that the communities in the vicinity of the wetlands in the Lake Kyoga basin were clearly aware of the multitude of benefits they derived from their access to such natural resources. Historical trends toward declining quality of the natural resource base were also clearly perceived by the communities, who bemoaned the declining soil productivity, reduction in wildlife resources, increasing fuel wood shortages, and falling fish catch resulting from over utilization. Wetland cultivation and trade were both observed to be on the rise, as was increased utilization of wetland resources for brick making, building materials, and firewood.

The nature of the structures to control utilization and the relevant regulations regarding use, however, were clearly not understood by the broader community.

Analysis of the economic contribution of wetlands resources to household income clearly shows the importance of this resource base to the household economy in the area. Triangulation of estimation procedures comparing PRA estimates with household level survey data collected using two difference estimation procedures revealed a surprising consistency of results. On average households in the study area obtained benefits from wetlands utilization valued in excess of 500,000 shillings per year from fishing, grazing, irrigation, fuel-wood collection and access to building and craft materials.

This diversity of wetlands benefits was consistent with the general tendency for households to minimize risk by engaging in a wide range of income generation activities. Clearly agriculture is by far the largest income source for these communities, but nearly 80% of the households were engaged in at least one off-farm income activity while more than 36% had two or more such non-farm income sources. Similarly agricultural production itself was diversified, with households producing a wide range of crops and raising various types of livestock.

6.1.2 Determinants of Wetland Utilization Diversity

With the Wetland Diversity index (WDI) as the dependent variable some of the factors that are found to significantly affect it are: location, prevalence of irrigated agriculture or cultivation, ease of access to the swampland, value derived from hunting in the wetland, fishing for consumption and for sale, value of fuel wood collected from the wetland, value of building materials derived from the wetland, and livestock income derived out of grazing the animals on the pasture in the wetland. Value or income derived from the wetland is found to most significantly affect wetland diversity. However, extraction of fuel products, building products, and livestock grazing were shown to have non-linear relationships with wetland diversity. Their respective squared variables all have significant negative coefficients, which shows that at a certain higher level of involvement, extraction of fuel and building/craft products or livestock grazing becomes the major household activity to the exclusion of others, reducing the diversity of wetland uses by the household. It is noted that the level of household food security does not significantly affect the diversity of wetland utilization.

6.1.3 Determinants of Food Security

Based on the results of the ordered probit model, it is observed that the factors that significantly affect the food security index are: value of fish products, log of farm size, and log of non-farm income (significant at 1%). Presence of irrigation and value of gifts were positive and significant at the 5% level. The increased access to income from various sources; fishing, livestock, non-farm activities, and gifts; improves the potential for the household to gain access to food through local purchases. Similarly, access to the means of production; especially land and irrigation improves a household's capacity to produce food for subsistence, while participation in fishing improves both income and the quality of the diet and hence the food security.

The strongest variable by far, however, proved to be that of “vulnerability” which displays a strongly negative coefficient. The vulnerability of a household was determined by the absence of adult family members as potential income earners. These vulnerable households, which are either child headed or headed by elderly persons beyond the normal income generating age, face extreme problems of poverty and their food security is severely at risk.

The diverse determinants of Food Security in the Lake Kyoga catchment area, illustrates the increasing integration of even this isolated area into the market, and the diversity of coping strategies being implemented by rural households. Rural households spread risk by embarking on a range of income generation strategies as confirmed by the community and household level data on sources of income (Figures 2-5.) and the household level data on coping strategies during times of food shortage. (Figure 1)

Wetland development has historically been primarily directed at agricultural and industrial expansion to meet the needs of urban areas, rather than devising development strategies that focus on the productivity of these ecosystems and respond to the needs of the poor rural producers who depend on them. To rectify this neglect, development approaches building on the productivity of the natural ecosystem and the essential interdependence of agricultural development and sustainable environmental management are now being developed (McNeeley and Scherr, 2001).

6.1.4 Determinants of Agricultural Productivity

The results of the productivity analysis show a considerable consistency. All of the equations were well defined. The mix of crops produced in the various districts was quite varied, with very few observations for some crops in some districts. As a result the dummy variable for certain districts was dropped in some equations. Even so, location is clearly an important determinant of productivity. In general, the coefficients on the dummy variables for district were highly significant – indicating considerable variability in productivity by district. It is only with groundnut and simsim production that location is a less significant determinant of productivity.

As expected, in nearly all cases, seasonality proved to be a significant determinant of productivity. The exception is beans, which are really only grown in first season. Certain crops, however, do better during first season, while others perform best in second season. This is largely the result of differences in rainfall and disease incidence, which is correlated with particular weather factors.

Increased investment in agricultural production inputs (ie. Purchase of improved seeds, fertilizer and pest control chemicals) was significantly associated with improved productivity for all crops except groundnuts. The exception for groundnuts is likely related to the fact that seed cost is very high, even for local varieties, and that the new rosette resistant varieties of groundnuts were not yet widely available at the time of the study. For this reason groundnut production remains very risky and prone to complete loss in the event of a rosette attack that is not caught early enough.

The use of simple bucket or trench irrigation was observed for five of the eight crops. Irrigation was found to be positively associated with productivity. The association was significant for cassava, sweet potatoes and maize, but insignificant for beans and sorghum (probably due to the limited number of observations). Unfortunately it was not possible to conduct an analysis of the impact of irrigation on horticultural crops or rice (where it is mostly used) because the range of crops was too diverse and the number of observations per crop proved too limited in the sample.

Interestingly, the larger the size of the plot, the lower the productivity when other factors like District, season and investment in inputs are held constant. This relationship was significant for six of the eight crops. This factor highlights the fact that there are critical labor constraints that inhibit timely planting and weeding as field size increases.

This raises the question of the relationship between availability of family labour and productivity. Clearly, the results for this analysis are mixed and difficult to interpret. There is a curvilinear relationship since both the "availability of family labour" and "family labour squared" are significant variables, and in each case the sign of the coefficient reverses when the variable is squared. As expected, for four crops (cassava sweet potatoes, maize and simsim) productivity showed initial positive returns to labour availability with gradual diminishing returns as availability of labour increased (a positive coefficient on labour but a negative coefficient on labour squared). However, the other four crops, groundnuts, millet, sorghum and beans, were found to demonstrate first decreasing and then increasing returns to labour. This relationship was only insignificant for groundnuts, where other factors such as disease incidence are probably much more important.

The implication is that with millet, sorghum and beans, for small households, the addition adults in the household is associated with a decline in productivity whereas for large households, additional adults increase productivity. Since these are not high value crops, the demands of maintaining additional adult household members may actually draw resources away from crop production and redirect them into other activities such as non-farm income generation or fishing. Additional analysis that tried to determine the relationship between the level of off-farm income and crop productivity showed a similar pattern of diverse signs depending on the crop. Clearly there is a complex inter-relationship between family size, allocation of family energies and resources between competing activities, and crop productivity which is not easy to tease out of cross sectional data which spans such a diversity of farming systems. This is a subject that requires further study.

6.1.5 Relationship between Productivity, Food Security and Wetlands Utilization.

The correlation analysis shows a weakly significant positive relationships between Food Security and Diversity of Wetland Utilization ($r=0.11^*$, $p\text{-value}<0.01$)[23]. This implies that increasing one will be positively associated with increases of the other, although the relationship is not strong. The relationship is unlikely to be causal, but rather results from the fact that both are positively associated with other variables such as value of crop production and off farm income as seen in the table.

The relationship between Productivity and both Food security and Wetland Utilization, however, is much stronger (significant at the 5% level). This shows that improving productivity is likely to

[23] Note that this correlation is between Food Security as a four point index and Wetlands utilization expressed as a dummy variable (eg. categorized as simply high or low). The relationship while still positive is even weaker when Wetlands utilization is considered as a 5 point index. This finding is consistent with the insignificant coefficients on these variables in their respective maximum likelihood estimates.

improve food security, and that there is no intrinsic contradiction between wetlands utilization and increased productivity per se. While correlation is not causation, the positive relationship implies that it is not necessary to sacrifice one of the objectives of the critical triangle in order to achieve another. Rather than being mutually exclusive, it is imperative that policy seeks to maximize all three in order to achieve the most sustainable and balanced path of development to serve human long-term interests.

6.2. Recommendations

Uganda national policy stresses three central principles of wetlands utilization and conservation (National Wetlands Conservation and Management Programme, 1999, p. 2-3).

"The hydrological and ecological integrity of the wetland ecosystem must be maintained"

Sustainable use of wetlands, or wise use according to the Ramsar terminology, means using wetlands for a variety of different purposes or activities. Use will almost always mean that the original conditions of the wetland will change. This in itself is not a problem so long as the main ecological processes are maintained**.** Management options for resilient wetlands are quite diverse as they pose little threat to the ecological integrity of the system as a whole.

Management must comply with larger ecosystem management objectives

Wise use of wetlands has to be considered also in the context of wise use of the ecosystem as a whole. Proposed wetland management options, therefore, will have to support wider ecosystem management objectives. In many cases this means that the scope of strategic management should encompass defined hydrological units, either catchments or river / lake basins.

Wetland management options must be supportive of the socio-economic objectives and aspirations of the people of Uganda
In many cases, improved management of wetland sections may increase the range of products derived from wetlands, increase the total harvested produce, or increase the value of the produce, all of which will help to improve the economic well-being of wetland users. Therefore, an integral part of the wise-use use of wetlands is the optimization of the socio-economic benefits within the restrictions of the former two principles; firstly to contribute to the wider development goals of Uganda, but also to muster continuing support for sustainable wetland management amongst all levels of Ugandan society."

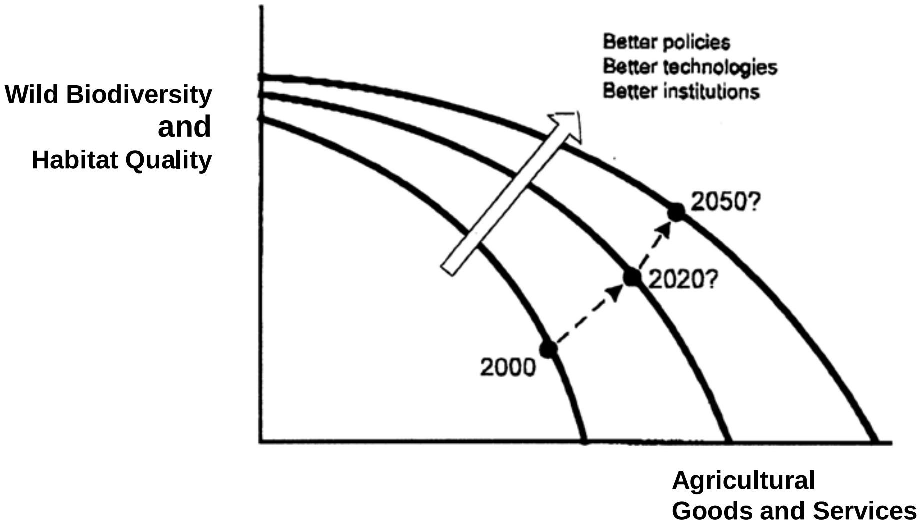
The principle is clear - wetlands conservation should be implemented to meet the diverse needs of Ugandan communities in both the short and long term. The difficult task, is to implement the policy within the context of rural communities that have no existing structures for the management of common property resources. The first recommendation of this study is that greater emphasis needs to be given to apply these principles in their entirety, with conscious policy formulation to promote systems for maximizing sustainable agricultural output to meet the needs of the growing population, while simultaneously striving to protect the important hydrological functions of the wetlands and their precious biodiversity. To date, the emphasis on meeting community needs is largely lip service, while regulatory efforts concentrate on stopping further exploitation for agricultural purposes. This is shortsighted. Individual initiative will continue to push the margins of irrigated agriculture to respond to the urgent food needs of a growing population. Wetland protection policies must be structured in such a manner as to encourage best practices, rather than simply stopping production.

To achieve this objective, it is important that local communities understand the classification of their local wetland resources and the regulations applying to that classification, so that appropriate local utilization policies can be enacted and enforced. Currently due to ambiguous land laws, the “ownership” of wetlands remains a point of contention. Households living in the vicinity of extensive wetlands clearly feel that they have traditional use rights and ownership privileges related to the wetlands. This leads to severe problems of non-conforming use. The formation of Common Land Associations to implement wetlands management schemes for the benefit of the community at large needs to be actively piloted and the resulting lessons promoted for broader implementation.

Agricultural productivity must be the engine of growth for Uganda. This requires substantial investment in breaking the critical constraints facing the sector. The worst of the distortions created by price controls and government subsidies for provision of services have been removed. Macro financial policy reform has achieved as much as it can, but the agricultural sector is still beset with inefficiencies resulting from its subsistence roots. Small farmers remain trapped in a vicious cycle of “low input-low output” production. Strategies to facilitate and strengthen private sector led growth need to be developed. It will not happen automatically. Investment in the agricultural sector needs to be increased, but channeled into facilitating services such as rural credit, strengthening of private sector input distribution, providing access to market information, encouraging market linkages, and strengthening of agricultural education.

Lack of access to appropriate irrigation technology and skills is another of the critical constraints that needs to be broken. Because of the current low level of irrigation, Uganda is in the enviable position of being able to learn from the rest of the world’s mistakes in forging its irrigation policies. Large scale subsidized irrigation schemes have proven to be management intensive and often uneconomical. They usually fail to create the right incentive to promote water control and management, resulting in lowered water tables and salinity problems. There is tremendous potential for adaptation of low-cost small-scale technologies perfected in Asia (treadle pumps and drip irrigation systems), which are more environmentally friendly and economically suited for the transition from subsistence to small-scale commercial production. However, it will not happen without a degree of public investment. Commercially oriented distribution systems for low cost technologies need to initially be facilitated and supported to

There is tremendous potential for adaptation of low-cost small-scale technologies perfected in Asia (treadle pumps and drip irrigation systems), which are more environmentally friendly and economically suited for the transition from subsistence to small-scale commercial production. However, it will not happen without a degree of public investment. Commercially oriented distribution systems for low cost technologies need to initially be facilitated and supported to grow to an economically viable scale of operation, but once established, they can then achieve financial sustainability. Favorable policies also need to be formulated that encourage the adoption of such technologies and best practices. The current ban on cultivation within 100 meters of a major water body is unrealistic and makes small-scale irrigation too expensive to serve the needs of the small producers who are potentially the most ecologically friendly water users. Instead, pressures for expanded irrigated acreage need to be channeled in the right direction by a combination of “push” and “pull” incentives. The “push” out of fragile and unsuited environments can be achieved through appropriately formulated community controls on wetland drainage and cultivation. Similarly, farmers can be "pulled" into more sustainable fringe cultivation with the availability of appropriate low cost technologies for water delivery, soil fertility management and improved upland varieties.It is not necessary to sacrifice one of the objectives of the critical triangle in order to achieve another. Rather than being mutually exclusive, it is imperative that policy seeks to maximize all three in order to achieve the most sustainable and balanced path of development to serve long-term human interests. Diversity of wetlands utilization, improved food security and enhanced agricultural productivity can more than coexist, they can become mutually enhancing. What is required is a conscious effort to pilot and promote the necessary improvements in institutions, technology and environmentally friendly production practices to simultaneously push out the production frontier and enhance biodiversity and wetlands conservation as envisioned and presented in the graph below.



From **McNeely and Scherr, 2001**. p. 78

APPENDICES

Appendix 1. The Wetlands Management Continuum

The Wetlands Management Continuum					
5V Priority Class	**I – Vital critical[24]**	**II – Vital not critical**	**III – Valuable critical**	**IV – Valuable not critical**	**V –Victim / Vanquished**
Management option	**Total Protection**	**Conservation HIGH**	**Conservation LOW**	**Conversion LOW**	**Conversion HIGH**
Description ------------------------------- ---- Activity types	Total protection of the ecosystem; access and use very restricted.	Total protection of the ecosystem; some sustainable uses and access allowed.	Reduced protection of the system; wider sustainable use and access allowed; hydrology not modified.	Limited ecosystem modification allowed; hydrology may be managed; no drainage or infilling.	Total modification of the natural environment allowed, including hydrology.
Tourism, research					
Biodiversity protection: Ramsar sites					
Renewable resource harvesting					
• Water (domestic & livestock)					
• herbaceous plants					if converted to pasture
• grazing of livestock (traditional)					
• timber					
• fishing (traditional)					
• hunting					
Non-renewable resource harvesting					
• sand and clay					
Enhancement of existing species					
• tree planting					

24 CRITICAL: is a qualifier and refers to a time element or to urgency in the need for immediate action e.g. gazetting, to curtail further abuse and degradation of the wetland or its attributes and associated resources.

The Wetlands Management Continuum					
5V Priority Class	**I – Vital critical[24]**	**II – Vital not critical**	**III – Valuable critical**	**IV – Valuable not critical**	**V –Victim / Vanquished**
• increasing existing fish stocks					
Introduction of new species					
• wetland tolerant crops (1)					
• trees (2)					
• fish (3)					
• wetland rice					
Ecosystem modification					
• small scale crop irrigation					
• fish pond development					
• liquid waste disposal					
• solid waste disposal					
• finger ponds					
• drainage - limited					
• drainage - total, land making					
Infra-structure developments					
• urban - residential, industrial					
• rural large scale irrigation schemes					
• rural conversions to dairy farms					
• permanent dwellings					

(1) yams, sugar cane, vegetables etc. (2) excluding very water demanding species (3) excluding mirror carp

Appendix 2. THE 5V's PRIORITY CLASSES and DEFINITIONS

CLASS I - VITAL WETLANDS (Critical)

- these wetlands are of such importance that they need immediate and effective management and protection from ongoing development and degradation,
- these wetlands provide at least one known essential good or service or other attribute for which there is either no alternative source of supply; or the alternative is not practically or economically viable,
- they include:-
- ❑ wetlands that provide and help purify urban drinking water supplies,
- ❑ those treating wastewater,
- ❑ provide major flood protection and flow regulation / seasonal redistribution of water,
- ❑ provide dry season water supply for livestock / wildlife in arid zones; oasis wetlands,
- ❑ wetlands which harbour rare, endangered or endemic species,
- ❑ wetlands with an especially high biodiversity value,
- ❑ wetlands that are unique or 'type' wetlands for the district,
- ❑ wetlands of international importance,
- ❑ Ramsar and other protected area wetlands.

CLASS II – VITAL WETLANDS (Non-critical)

- these have the same characteristics as Class I but are not currently under development or degradation but still require a high level of protection to avert future problems.

CLASS III – VALUABLE WETLANDS (Critical)

- these provide essential resources comparable to Class I and II but these resources are available economically from alternative sources, though these may be less economical and of poorer quality,
- they are classified as critical because they are subject to ongoing degradation, which jeopardises the continuation of their attributes or existence.

CLASS IV – VALUABLE WETLANDS (Non-critical)

- these are defined as per Class III above but are not subject to ongoing degradation.

CLASS V – VARIOUS WETLANDS

- these either do not provide essential goods or services upon which many people depend or, they do provide such resources but these are so locally abundant that degradation or over-harvesting is unlikely in the foreseeable future;
- they harbour no endangered, endemic or rare species, nor unique habitats; they represent the majority of the nations wetlands

- ❑ ***VICTOR*** wetlands are generally too big to be seriously threatened by wholesale drainage or permanent degradation by existing technology; this threat may however grow in future; these are!
- ❑ ***VICTIM*** wetlands are dispensable wetlands that could be ‘sacrificed’ or traded for other socio-economic development uses e.g. agriculture or urban development;
- ❑ ***VANQUISHED*** wetlands are those that are either (1) totally converted to productive alternate uses e.g. dairy farming or irreversible urban development; these should remain converted: (2) those totally converted but not productively used; restoration should be applied where economically viable.

Appendix 5. Determinants of Productivity – Detailed Analysis Results

Estimated covariances =	167		Number of obs =	187	115		Number of obs =	141	46		Number of obs =	54
Estimated autocorrelation =	0		Number of groups =	167	0		Number of groups =	115	0		Number of groups =	46
Estimated coefficients =	18		Obs per group: Min=	1	18		Obs per group: Min=	1	12		Obs per group: Min=	1
			Avg =	1.245989			Avg =	1.397163			Avg =	1.296296
			max =	3			max =	3			max =	2
			Wald chi2	1116.39			Wald chi2	5938.43			Wald chi2	148.41
Log likelihood =	-143.124		Pr > chi2 =	0	-114.224		Pr > chi2 =	0	-12.2101		Pr > chi2 =	0
	Cassava				**Sweetpotato**				**Groundnuts**			
lnincacr	Coef.	Std. Err.	z	P>|z|	Coef.	Std. Err.	z	P>|z|	Coef.	Std. Err.	z	P>|z|
ss2	0.0308	0.0631	0.489	0.625	-0.7694	0.1461	-5.265	0.000	0.3671	0.0940	3.904	0.000
ss3	-0.4612	0.1708	-2.700	0.007	-0.6458	0.1596	-4.048	0.000	dropped due to collinearity			
ss4	-0.9388	0.6152	-1.526	0.127	-0.9014	0.2035	-4.431	0.000	dropped due to collinearity			
irrigatd	0.5961	0.1193	4.996	0.000	0.6908	0.0900	7.673	0.000	dropped due to collinearity			
logacres	-0.1193	0.0272	-4.386	0.000	-0.2637	0.0733	-3.599	0.000	-0.4218	0.1028	-4.104	0.000
Family labour	0.2536	0.0311	8.143	0.000	0.1036	0.0505	2.053	0.040	-0.1222	0.1107	-1.105	0.269
Labour2	-0.0204	0.0027	-7.462	0.000	-0.0087	0.0041	-2.103	0.035	0.0183	0.0092	1.989	0.047
invest	0.0039	0.0005	7.295	0.000	0.0274	0.0013	21.054	0.000	0.0001	0.0030	0.018	0.985
dd1	0.5057	0.0977	5.174	0.000	-2.0411	0.4910	-4.157	0.000	dropped due to collinearity			
dd4	-0.4977	0.0804	-6.189	0.000	-0.9275	0.4099	-2.263	0.024	dropped due to collinearity			
dd5	-1.1300	0.1091	-10.354	0.000	-2.1219	0.4062	-5.223	0.000	dropped due to collinearity			
dd6	0.3934	0.0901	4.369	0.000	-1.2315	0.3958	-3.111	0.002	0.8987	0.4120	2.181	0.029
dd7	0.0334	0.0742	0.450	0.653	-1.0731	0.3996	-2.686	0.007	0.5354	0.5512	0.971	0.331
dd8	0.8114	0.1332	6.090	0.000	0.1751	0.4094	0.428	0.669	0.7024	0.4765	1.474	0.140
dd9	-0.0093	0.1232	-0.075	0.940	0.0822	0.3875	0.212	0.832	0.9621	0.3605	2.669	0.008
dd10	-0.3199	0.1033	-3.096	0.002	-1.2246	0.4141	-2.957	0.003	-0.2066	0.3841	-0.538	0.591
dd11	0.2348	0.0715	3.282	0.001	-0.8152	0.3916	-2.082	0.037	0.3971	0.3783	1.050	0.294
_cons	4.2641	0.1142	37.327	0.000	5.2222	0.4238	12.322	0.000	3.1584	0.4708	6.708	0.000

Estimated covariances =	93		Number of obs =	106	95		Number of obs =	127	124		Number of obs =	183
Estimated autocorrelation =	0		Number of groups =	93	0		Number of groups =	95	0		Number of groups =	124
Estimated coefficients =	17		Obs per group: Min=	1	16		Obs per group: Min=	1	17		Obs per group: Min=	1
			Avg =	1.264151			Avg =	1.503937			Avg =	1.644809
			max =	3			max =	2			max =	2
			Wald chi2	449.83			Wald chi2	21943.14			Wald chi2	1082.65
Log likelihood =	-96.1581		Pr > chi2 =	0	-101.274		Pr > chi2 =	0	-157.803		Pr > chi2 =	0
	Millet				**Sorghum**				**Maize**			
lnincacr	Coef.	Std. Err.	z	P>|z|	Coef.	Std. Err.	z	P>|z|	Coef.	Std. Err.	z	P>|z|
ss2	-0.7147	0.3567	-2.004	0.045	3.1428	0.1466	21.434	0.000	(dropped)			
ss3	-0.8604	0.3828	-2.247	0.025	3.5175	0.1443	24.371	0.000	-0.1265	0.0263	-4.804	0.000
ss4	-0.0499	0.3429	-0.146	0.884	dropped due to collinearity				dropped due to collinearity			
irrigatd	dropped due to collinearity				0.0832	0.4542	0.183	0.855	0.6119	0.2126	2.878	0.004
logacres	-0.9185	0.1203	-7.638	0.000	-0.1589	0.0525	-3.030	0.002	-0.2184	0.0488	-4.477	0.000
Family labour	-0.2549	0.0983	-2.594	0.009	-0.2617	0.0448	-5.841	0.000	0.0577	0.0377	1.531	0.126
Labour2	0.0289	0.0092	3.143	0.002	0.0314	0.0046	6.807	0.000	-0.0076	0.0027	-2.855	0.004
invest	0.0342	0.0124	2.752	0.006	0.0902	0.0164	5.482	0.000	0.0552	0.0037	15.054	0.000
dd1	(dropped)				(dropped)				-0.2100	0.0888	-2.366	0.018
dd4	-1.2910	0.3909	-3.302	0.001	(dropped)				-0.6477	0.0838	-7.733	0.000
dd5	-1.8974	0.6313	-3.005	0.003	(dropped)				-1.0396	0.2622	-3.965	0.000
dd6	-1.3749	0.2994	-4.593	0.000	0.3095	0.0992	3.120	0.002	0.7457	0.1169	6.377	0.000
dd7	-1.3056	0.2861	-4.564	0.000	0.5586	0.1194	4.677	0.000	-0.7227	0.0811	-8.913	0.000
dd8	(dropped)				0.4283	0.1823	2.350	0.019	-0.1729	0.0906	-1.907	0.057
dd9	-4.1017	0.4666	-8.791	0.000	dropped due to collinearity				-0.5425	0.0862	-6.293	0.000
dd10	-0.1786	0.2662	-0.671	0.502	-0.0531	0.1271	-0.418	0.676	-0.8658	0.0917	-9.442	0.000
dd11	-0.7450	0.2820	-2.642	0.008	0.0090	0.0906	0.099	0.921	-0.5901	0.1254	-4.705	0.000
_cons	5.8924	0.4715	12.497	0.000	(dropped)				3.9814	0.0849	46.897	0.000

Estimated covariances =	79	Number of obs =	98		46	Number of obs =	51	
Estimated autocorrelation =	0	Number of groups =	79		0	Number of groups =	46	
Estimated coefficients =	16	Obs per group: Min=	1		12	Obs per group: Min=	1	
		Avg =	1.387755			Avg =	1.196078	
		max =	2			max =	2	
		Wald chi2	538.99			Wald chi2	2233.12	
Log likelihood =	-71.9023	Pr > chi2 =	0		-14.834	Pr > chi2 =	0	
	Beans				**Simsim**			
lnincacr	Coef.	Std. Err.	z	P>|z|	Coef.	Std. Err.	z	P>|z|
ss2	0.0716	0.0624	1.146	0.252	0.4900	0.1015	4.828	0.000
ss3	dropped due to collinearity				dropped due to collinearity			
ss4	dropped due to collinearity				dropped due to collinearity			
irrigatd	0.4140	0.3186	1.299	0.194	(dropped)			
logacres	-0.5232	0.0591	-8.853	0.000	-0.0324	0.1121	-0.289	0.772
Family labour	-0.2157	0.0671	-3.215	0.001	0.3003	0.1193	2.518	0.012
Labour2	0.0334	0.0083	4.002	0.000	-0.0230	0.0119	-1.930	0.054
invest	0.0227	0.0051	4.480	0.000	0.0164	0.0026	6.417	0.000
dd1	-0.4629	0.2633	-1.758	0.079	0.9022	0.2526	3.572	0.000
dd4	(dropped)				(dropped)			
dd5	(dropped)				dropped due to collinearity			
dd6	0.2964	0.2665	1.112	0.266	dropped due to collinearity			
dd7	-0.5888	0.2617	-2.250	0.024	0.3209	0.2118	1.515	0.130
dd8	-0.3936	0.3745	-1.051	0.293	dropped due to collinearity			
dd9	-0.6716	0.2684	-2.502	0.012	dropped due to collinearity			
dd10	-0.8762	0.4535	-1.932	0.053	(dropped)			
dd11	-0.1934	0.4979	-0.388	0.698	-0.2594	0.2106	-1.232	0.218
_cons	4.0020	0.2811	14.239	0.000	2.7992	0.3737	7.490	0.000

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CHAPTER THREE

Land Tenure, Agricultural Productivity and the Environment in Kenya.

Paul O. Obunde, Cyrus M. Mbogo, Willis Oluoch-Kosura and Agnes W. Kamoni

Land Tenure, Agricultural Productivity and the Environment in Kenya

1.0 INTRODUCTION

1.1 Backgroun

Kenya has a total surface area of 592,909 km^2, out of which total land area is 581,679 km^2. Only about 17 percent of this land area is arable, of high to medium potential for agriculture and intensive livestock production. The rest of the land is classified as arid or semi-arid lands (ASALs) and mainly used for extensive livestock rearing and wildlife (GoK, 2001b).

Most Africans live in the rural areas and rely on land for their livelihood (Zinyama, 1999). Most of them live below the poverty line. In Kenya, 87 percent of the population lives in the rural areas and subsistence farmers account for over 50 percent of the total poor (PRSP 2001).
Farm sizes vary widely, with the largest farms being found in the low rainfall rangelands. 3.5 million smallholder farms possessing 3.2 million hectares while 3,600 large farmers account for 2.7 million hectares. (Table 1). With increasing population, available per capita arable land is diminishing, with some densely populated regions such as Kisii and Rachuonyo districts already registering less than half an acre per person. Most of the land in these areas is undergoing land subdivision as a result of inheritance and increasing land sales.

Table 1: Farm Holdings by Size

Size of land holding	Area in mil. Ha	No. of holdings	Average size in ha
Small farms (<10 ha)	3.2	3,528,000	1.2
Medium farms (10 – 60 ha)	1.04	68,400	20
Large farms (>60 ha)	2.7	3,600	778
Total	**6.9**	**3,600,000**	**2.5**

Source: MOALD

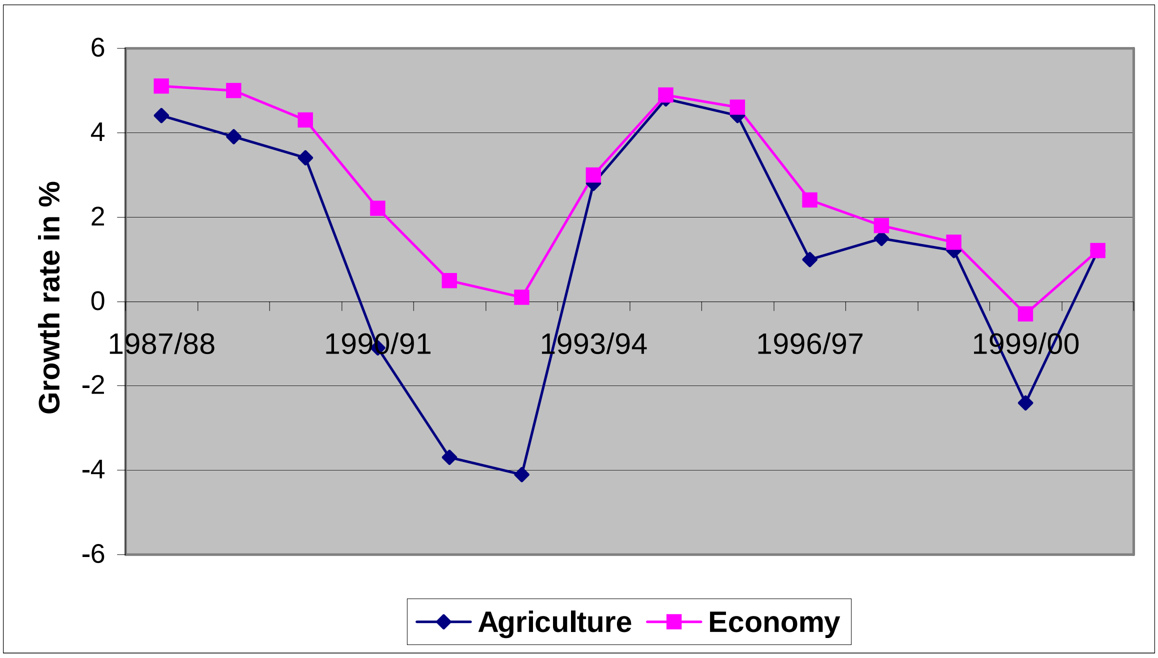
With the increasing demand of land for various uses, comprehensive land reforms are crucial. In Africa, land reforms induce changes in land use patterns thereby affecting the environment (Zinyama, 1999). Unresolved land reform and land tenure security issues pose major bottlenecks because of their implications for agricultural productivity and conservation of natural resources. Land use policies should encourage growth in agricultural productivity and employment, better conservation of existing land and natural resources, and sustainable agricultural development.

This paper is organized as follows: The next section gives a brief background on past performance of Kenya's agricultural sector, the problem statement, objectives and study hypotheses. Section two offers the literature review. The methodology is discussed in Section three. Section four provides the study findings, conclusions and policy implications.

1.2 Past performance of the agricultural sector

The performance of Kenya's agricultural sector has deteriorated in last decade, stifling overall economic growth. Since a large proportion of Kenyans lives in rural areas and depends on agriculture. Most livelihoods have been adversely affected by this trend, and poverty levels have increased. In 2000, the agricultural sector growth registered a decline of 2.1 percent, contributing to negative growth in the overall economy (Omiti and Obunde, 2002). Recovery of the sector to a 1.2 percent growth the following year raised the overall economy growth rate by the same margin.

Figure 1: Growth Rates of Agricultural Sector and the Economy



Source: Omiti and Obunde 2002

Figure 1 shows a direct positive relationship between growth in the agricultural sector and the economy. Whenever the agricultural sector performed well, the economy also performed well. Although some research disputes the causality between agriculture and economy, it is evident that currently the economy cannot grow if the agricultural sector performs poorly. It is also clear from Figure 1 that the agricultural sector has been growing at less than 2 percent per annum over the last 4 years, a rate lower than Kenya's population growth rate of 2–3 percent.

Moreover, agricultural productivity has been declining in many parts of the country. For instance, maize yield at 2 tons[25] per hectare[26] is far below its potential of over 6 tons per hectare achievable with improved seeds, fertilizers and good crop husbandry (MOALD, 2001, MOFP 2001b). This dismal performance is blamed on several factors, including the high cost of inputs, lack of quality seeds and credit, limited application of new agricultural technologies, inadequate extension support, and lack of clear land use policies (MOALD, 2001).

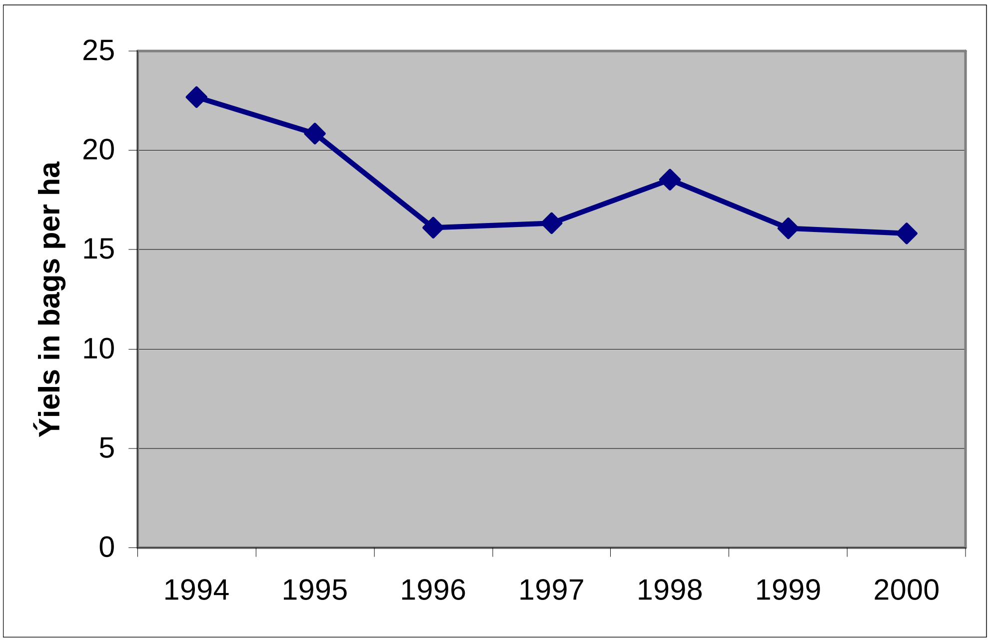
[25] One tonne is equivalent to about 11.1 bags of 90 kgs.

[26] One hectare is equivalent to about 2.47105 acres.

1.3 Statement of the problem

Land scarcity is increasingly becoming a major concern in agricultural production. The mounting pressure on land has resulted in many land disputes, violent clashes and pending suits in courts. It has also resulted in overexploitation of water catchments, leading to declining river water flows and lower groundwater levels. Continuous use of the same piece of land every year has led to declining maize crop yields over time (Figure 2). In most cases, the decline has been caused by gradual loss of soil nutrients through erosion and leaching, necessitating greater dependency on fertilizers, erratic weather conditions from deforestation, and market-related constraints (MOALD, 2001, MOFP, 2001b).

Figure 2: Kenyan Maize Productivity, 1994-2000



Source: MOALD, 2001

Sustainable crop production is important for any economy. But for this to occur, increasing crop yields today should not be accompanied by increased environmental degradation. It is important to evaluate the relationship between land tenure, land productivity and the environment since a better management of land resources is good for poverty reduction (DFID et al 2002).

Land tenure issues are increasingly becoming significant in rural development and are emerging as the most serious agrarian issues in the 21st century. Sensitivity to land issues reflects the real and perceived value attached to land (FAO, 1993). In Kenya, the problem of tenure security has increased as evidenced by many cases of illegal encroachment into public and private land, as well as conflicts related to land.

Cases of discrimination in access to land or possession of tenure security are common. Despite being the main agricultural producers, only 2 percent of women own land; most do not have security of tenure, mainly due to land inheritance laws that discriminate against them (FAO 2003a; FAO 2003b; Ravensburg 1999).

Given the long-term nature of investment in environmental conservation, farmers will likely invest only if the present value of benefits from the investment is higher or equal to the present value of the costs incurred. This is also influenced by the farmer's perception of the probability that he or she will maintain the rights to use the land for the whole duration of the investment (Carter et al 1994; DFID et al 2002; Vosti and Reardon 1997). The higher the perceived probability and benefits, the higher the chances of investing in environmental conservation. However, other important determinants will be the farmer's discounting factor and overall cost of the investment.

There are three major systems of land tenure in Kenya: individual, communal state land tenure. Individual land tenure refers to individual freehold ownership of land. This system was promoted since 1954 following recommendations of the *Swynnerton Plan for the Modernization of African Agriculture*, which recommended the tenure conversion from communal systems through adjudication, registration and titling of land. The title confers security of tenure by registering the absolute rights of ownership to the holders after adjudication. It encourages investment on land, facilitates access to credit, create a land market, minimizes land disputes, and facilitates intensification of agricultural production, thus increasing land productivity (Swynnerton, 1954). The Plan was also aimed at consolidating fragmented land holdings and aid land redistribution (Zinyama, 1999).

Communal land ownership refers to land owned jointly by a group of people, or a community. In this case, land usage is determined jointly or by customary laws and norms. No individual can sell any part of the land or use it as security for accessing financial loans. Land is, thus, considered a public good with possibilities of 'free riding' particularly when it comes to investment in land conservation.

The state land tenure refers to public land set aside for agricultural and non-agricultural use. Most of such land is occupied by forests, water catchments and any other public-interest activities, such as game reserves, historical sites, etc. In Kenya, the government has set land aside for agricultural research as well. Being public goods, there is always a risk of losing these areas to individuals in disregard to their importance in flora and fauna conservation. Massive environmental degradation due to illegal encroachment is common.

This study postulates that there is a well-established relationship between land tenure security and the land conservation investments, and improvement and proper management of land and other natural resources. Farmers with secure rights to land have the incentive to make necessary land improvements and take measures to conserve soils and maintain the fertility of the land, all of which positively influence sustainable agricultural productivity.

1.4 Objectives and Hypothesis of the Study

The overall study objective is to establish the relationship between land tenure security, agricultural productivity and the environment. The specific objectives of the study are to establish the relationship between security of tenure and agricultural productivity; identify links between security of tenure and investment in environmental conservation and soil fertility enhancement and maintenance; and establish linkage between tenure security and environmental degradation.

In order to achieve these objectives, the following hypotheses were tested: (1) land productivity is directly and positively related to land tenure security; (2) there exists a positive relationship between land tenure security and investment in environmental conservation; (3) there is a close linkage between tenure security and environmental degradation; and (4) title deeds enhance accessibility to credit.

2.0 LITERATURE REVIEW

Land degradation is a serious global problem with estimates of up to 36 million square kilometers of cropland or 28 percent of the world's total cropland degraded since mid-century. The degradation is most serious in Africa where the proportion of degraded cropland has reached 65 percent (Fatondji et al 2001). In particular, destruction of plants as a result of settlement and agricultural activities has resulted in serious environmental degradation in Eastern and Southern Africa (Mhlanga and Mapaure, 1999). For instance, Kenya's forests have been destroyed and now cover only 1.7 percent of the total land area, below the acceptable limit of 2 percent. Moreover, the country loses up to 12 million trees annually to charcoal alone (MENR, 2002; Daily Nation 2002a). The average proportion of forest cover in Africa is 9.2 percent and for the world it is 21.43 percent.

The effect of degradation has been throughout sub-Saharan Africa where half of farm land and 80 percent of the pasture and range areas show signs of soil erosion and degradation (Cleaver and Schreiber, 1994). Significant degradation has particularly been recorded in West African Sahelo-Sudanian Zone, Sudan, Somalia, Ethiopia and Kenya (Oldeman et al 1990). Increased pressure on the fragile ASAL areas has contributed to desertification (Mbithi and Barner, 1975; Heyer and Waweru, 1976).

Although the number of farmers investing adequately in environmental conservation is minimal, farmers are aware of the various causes of soil erosion and know appropriate mitigation measures (Sambo and Munyenyembe, 1999). In view of the importance attached to the relationship between population growth, agriculture and environmental degradation, it is important to investigate the effects of land tenure on the declining land productivity.

The study of the relationship between land tenure security and agricultural productivity has been undertaken previously. Studies carried out about a decade ago established no significant linkage between land tenure security and agricultural productivity (Blarel 1994; Migot-Adholla et al 1994a; Mortimore and Tiffen, 1994; Tiffen et al 1994; Migot-Adholla et al 1994b; Place and Hazell 1993). Some of the results showed that the coefficients for the secure land rights category were negative. In a few instances, some studies establish a weak but positive relationship between tenure security and crop yields.

In Zambia, Smith (2001) reported that most respondents did not cite land tenure security as a major constraint to agricultural productivity. Barrows and Roth (1989) carried out a study aimed at establishing the linkage between land tenure and land investments for improved and sustainable agricultural productivity, but did not consider a linkage to the environment. In Malawi, Dickerman and Bloch (1991) explored the relationship between land tenure and agricultural productivity.

Several studies have shown significant positive relationship between land tenure security and investments in land improvements (Blarel 1994; Migot-Adholla et al 1994a; Roth et al 1994; Mortimore and Tiffen, 1994; Migot-Adholla et al 1994b; Tiffen et al, 1994). These improvements include farm drainage, excavations, irrigation, digging wells, building access roads, removing tree stumps, terracing, fencing, planting trees, applying manure, liming the soil, and mulching. Environmental issues were, however, not critically analyzed.

Recent studies have attempted to focus on the environmental issues. A study in Philippines revealed that farmers with better land tenure security were more likely to install contour hedgerows to reduce erosion than those who had less tenure security (Shively 2001; DFID et al 2002). In Machakos and Kitui in Kenya, a study found a positive relationship between terracing and land tenure security and argued that tenure security served as an incentive these land investments. The same argument is supported by Gerrits (2001) in his study in Kitui district. The benefits of key environmental conservation investments such as terracing and tree planting are long-term and people without secure land tenure may not benefit. A study in Kitui and Machakos showed that it may take up to 48 years for a farmer to break even once soil conservation structures are constructed (Pagiola 1993).

Tenure security is crucial in the management of natural resources. Otsuka and Place (2001) argue that provision of ownership rights to every individual within the community is the incentive needed for management of timber forests. Studies undertaken in Rwanda and Ghana established a negative relationship between farm sizes and land productivity (Blarel 1994; Migot-Adholla et al 1994a). This result could be attributed to intensification of production as farm sizes become smaller. Some proponents of this argument recommend expropriation of land from those who have 'too much' to those who have little or no land (Zinyama, 1999).

However, it should be noted that continuous use of the same piece of land, with minimal environmental conservation would gradually result in reduced land productivity and the increasing need for fertilizer usage. In this regard, some authors argue for land consolidation (Zinyama, 1999). Others argue that small farms are less efficient than large farms with regard to use of productive factors (Jacoby, 1971). Studies undertaken in Macedonia, however, show that the relationship between farm sizes and land productivity is dependent upon the type of agricultural enterprise.

Further analysis showed that land fragmentation index correlates negatively and significantly with wheat yields, meaning that the higher the fragmentation lowers the yields (Melmed-Sanjak et al 1998). The study also established negative linkages between fragmentation and profit to farmers because of high travel costs between the numerous land parcels and the difficulty of using efficient cultivation techniques.

Blarel (1994) did not find any relationship between tenure security and credit in Rwanda but a weak linkage between the two variables was established in Ghana by (Migot-Adholla et al 1994a). In Kenya, it was established that farmers are reluctant to use their land titles as collateral because they lack confidence in their ability to repay loans (Migot-Adholla et al 1994b). In the meantime, the need for credit facilities continues to rise with the rising cost of inputs and need for environmental conservation.

In Kenya, a number of studies have been carried out on land tenure with a few relating it to agricultural productivity. The most notable one was undertaken during 1988 in the densely populated Nyeri and Kakamega districts (Migot-Adholla et al 1994b). Although the study looked into the relationships between land tenure, agricultural investment and farm productivity, it never established land tenure effects on the environment. It is more than a decade ago since the study was carried out and it would be interesting to see whether things have changed with time. Is it possible that the findings of the study and others carried out in other countries still hold? We have deliberately chosen agro-ecological zones that totally differ from those in the 1988 study so as to establish whether the relationships established in that study can hold in a totally different agro-ecological zone. This would form a good basis for the necessary policy formulation.

The agricultural sector in Kenya has registered poor growth over the last decade with growth falling to negative 2.4 percent in the year 2000 (Economic Surveys 1997 – 2001). This has been blamed on among others, increasing frequency of drought and falling agricultural productivity. These two may be an indication that Kenya is unable to achieve sustainable growth. Empirical evidence shows that environmental degradation, more so clearing of the bush, including those in major water catchment areas, can contribute to climate change and even desertification. Moreover, the usefulness of vegetation cover to formation of rainfall cannot be underestimated (Heyer and Waweru, 2000).

The declining land productivity, according to reports available at the Ministry of Agriculture and Livestock Development, has necessitated increased use of farm inputs such as fertilizer and farmyard manure. Increases in cost of these inputs has raised the cost of production and reduced the competitiveness of Kenyan agricultural products in local and international markets. In neighboring Uganda and Tanzania, the land is still relatively richer and requires almost no fertilizer or manure thereby making the cost of production of commodities like maize and beans lower than in Kenya.[27]

Various methodologies have been used in the past studies, varying based on data and researcher preferences. Migot-Adhola et al 1994a adopted single equation econometric models and relied on Logit regression models. This was critical for their data in which the dependent variables were binomial. The Ordinary Least Squares (OLS) may be used in cases where the dependent variable is continuous. Roth et al (1994) used such a method where land values formed the dependent variable. Migot-Adhola et al 1994a also used a continuous dependent variable, crop yield. Each model has to be carefully applied due to the possibility of mis-specification, multicollinearity, heteroscedasticity and autocorrelation. Some researchers use two- or three-stage least squares to deal with these problems. With discrete dependent variables or those requiring censoring, tobit regression analysis is more commonly used. An example is Otsuka et al (1997), in which the dependent variable was the proportion of area under different land tenure regimes.

To determine the nature of variables used, two variable analyses are often used, including Pearson Correlation Coefficient. In this study, various regression techniques are used, with the yield model being based on the OLS that is substantially reduced to minimize occurrence of mis-specification or simultaneity bias. A Tobit Model is developed for determinants of environmental degradation since the dependent variable requires censuring and is discrete. A Logit model is also used due to the dummy nature of the dependent variables.

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[27] It should be noted that these countries still have expanse of land to be cleared for cultivation and the soils have not been exhausted as in Kenya.

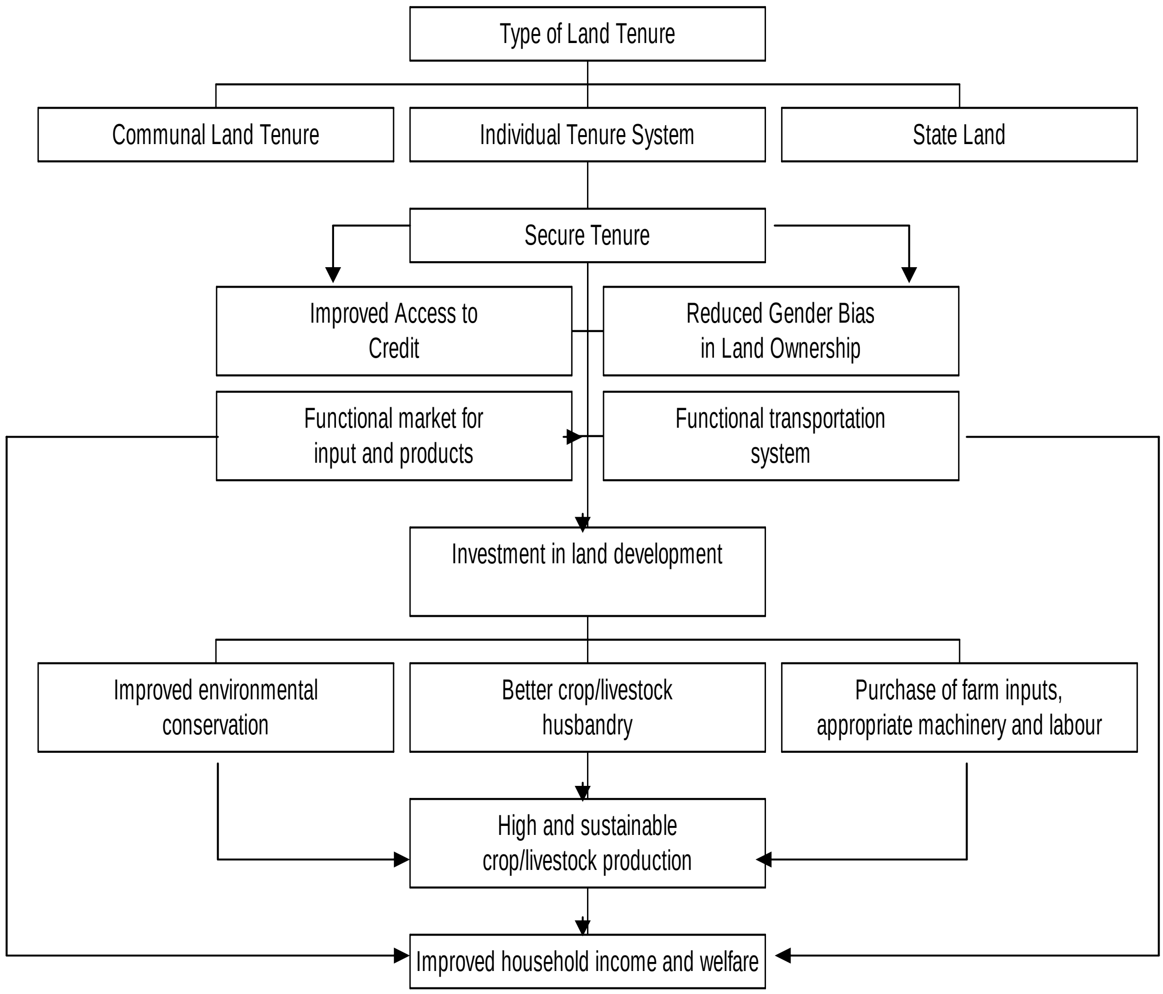
3.0 RESEARCH METHODOLOGY

3.1 Conceptual Model

Land tenure security and environmental management are important for sustainable agricultural development. Figure 3 presents a theoretical conceptual model that attempts to describe the relationship between land tenure security and sustainable agricultural production with environmental management linking the two.

The model hypothesizes an individual land tenure system. Communal and state land tenure systems are also important but do not provide as much tenure security to a farmer as the individual tenure system. In theory, tenure security would enhance access to credit, reduce gender bias in land ownership by allowing women to purchase and own land, and enhance investment in environmental conservation, better crop/livestock husbandry and use of better farm inputs.

Figure 3: Conceptual Model



Adapted from Frank Place et al 1994

The model also hypothesizes that investment in land development are determined directly input and produce market efficiency as well as existing roads and transport systems. Investment in land development refers to environmental conservation, better crop/livestock husbandry, and use of appropriate farm inputs. The specific investments include fencing, tree planting, grass-strips, sound crop husbandry, purchase of quality seeds, removal of tree stumps, leveling, terracing, ridging, road construction, well construction, water pans, and drainage systems, application of farm yard manure and fertilizer, mulching, among others. The output of such investments is sustainable crop and livestock production. With the high level of output, functional markets for inputs and output, and an efficient transport system contribute to higher household income and better livelihoods.

3.2 Data Needs and Sources

Data was collected on household characteristics (sex, age, level of education, occupation, household income and size of household); land productivity (crop yields); environment (cropping patterns, vegetation cover, environmental conservation methods and degree of environmental degradation); land tenure (type and user's right to sell land, designate heir to the land, rent out the land); access to credit (source of credit and whether land title was used as collateral); parcels of land owned; farm size; number of acres under maize; farm inputs (fertilizer, pesticides, manure and seeds); land investments (trees planted, fencing, ridges, water management structures, drainage, access roads, tree-stump removal, terracing, drilling of boreholes); proportion of land cultivated; and functioning of the inputs and produce markets.

The research team collected secondary data from various libraries, more so that for the Ministry of Agriculture and Livestock Development and the University of Nairobi. Some of the information and publications were accessed through the Internet while others were sourced from friends within the Public Service and Research Institutes. Some of the unpublished materials from the Ministry of Agriculture and Livestock Development; Ministry of Environment, Natural Resources and Wildlife; and Ministry of Planning and National Development were also screened and used. These materials were mainly used for the literature review and for verification of the primary data.

The primary data was collected in Suba and Laikipia Districts using both quantitative and qualitative techniques. Most of the quantitative data was collected using a detailed questionnaire that was pre-tested during the reconnaissance study. A combination of direct observation and informal interviews were also conducted to fill any gaps left by the questionnaires and to verify the information provided.

3.3 Study Sites

The study was undertaken in Suba district in Nyanza Province and in Laikipia district in Rift Valley Province (See Figure 4). The choice of these districts aimed at capturing as much of geographical, ecological and cultural diversity.

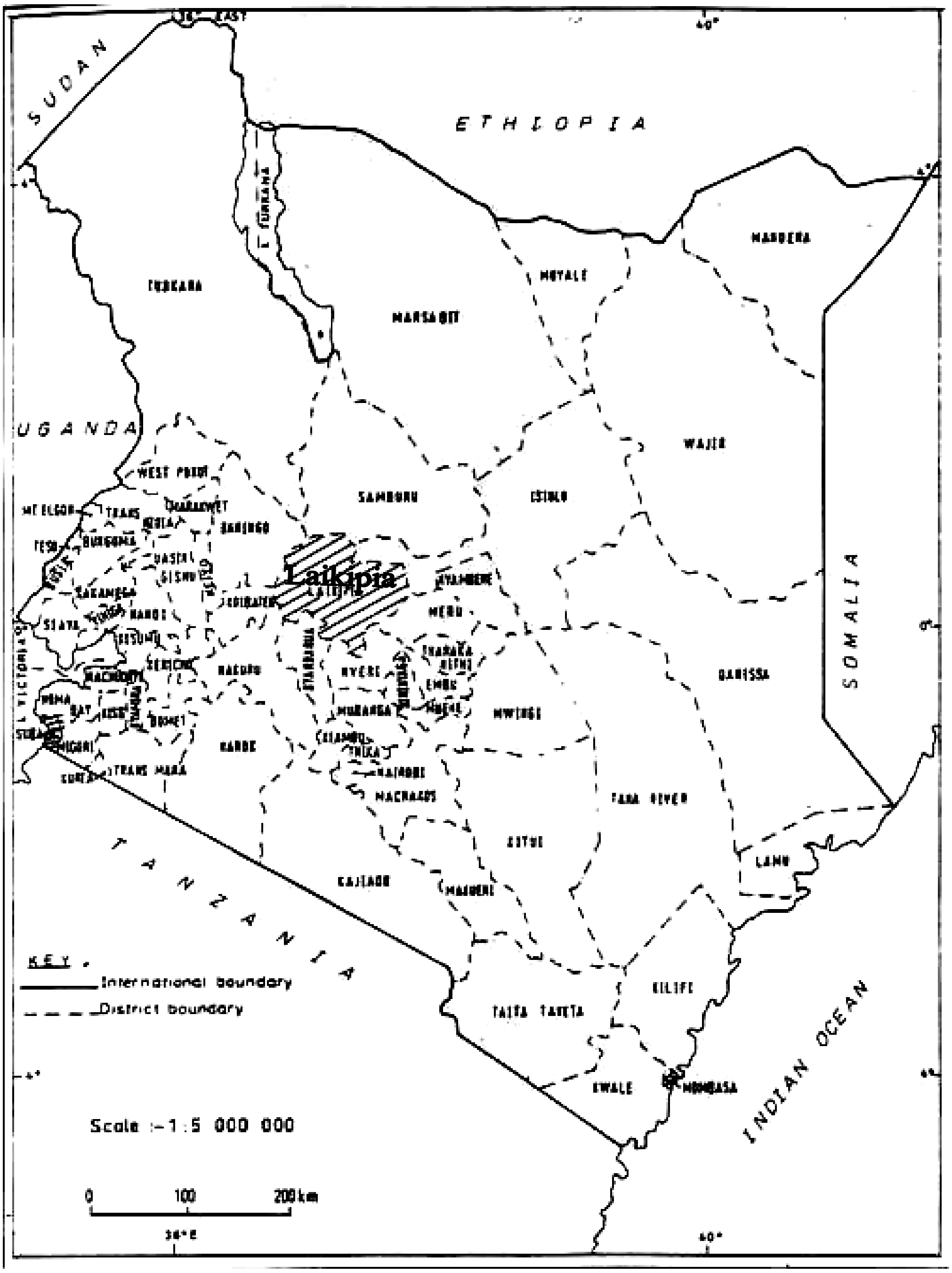
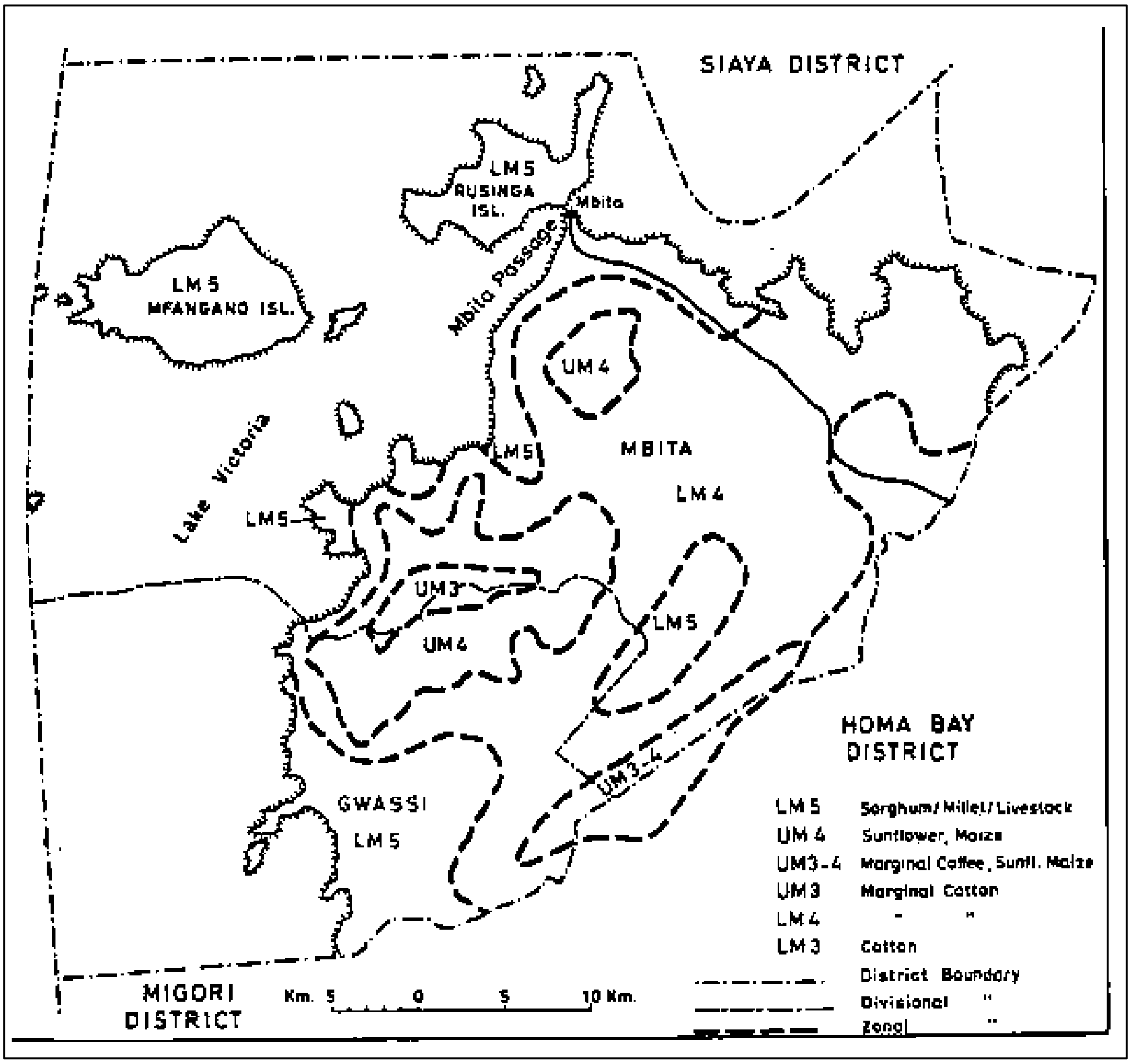


Figure 4: Location of the Study Districts

3.3.1 Suba

Suba district covers an area of 1,810 km^2 composed of 853 km^2 of water surface and the remaining 957 km^2 of land surface of which 530 km^2 is arable while another 157 km^2 is forest cover. The district is divided into 5 divisions namely Lambwe, Mbita, Central, Mfangano and Gwassi, with 20 administrative locations and 40 sub-locations. It has a population of 159,000 people with an estimated population density of 162 persons per square kilometer. The district has an inland equatorial type of climate that is modified by the effects of altitude and closeness to Lake Victoria. The average annual temperature ranges between 22^0C and 30^0C while the annual rainfall ranges from 700mm to 1200mm with 60 percent reliability.

Figure 5: Agro-ecological Zones of Suba District



Land in the district is generally hilly with thorny bushes. The soil type is mainly Vertisols (poorly drained low fertility clay) and phaeozems with evidence of rocky hills. There are signs of land degradation on the hills. The eroded soils are deposited in valleys where they form rich alluvial soils.

The district has two cropping seasons. The main season starts in February and ends in August. During the short rain season, the parcels of land are left fallow with the major activity being communal grazing. Those who plant crops or trees during this season have to take further precautions of guarding against livestock damage. Only about a quarter of the district's land is under cultivation while the rest is idle or under livestock farming.

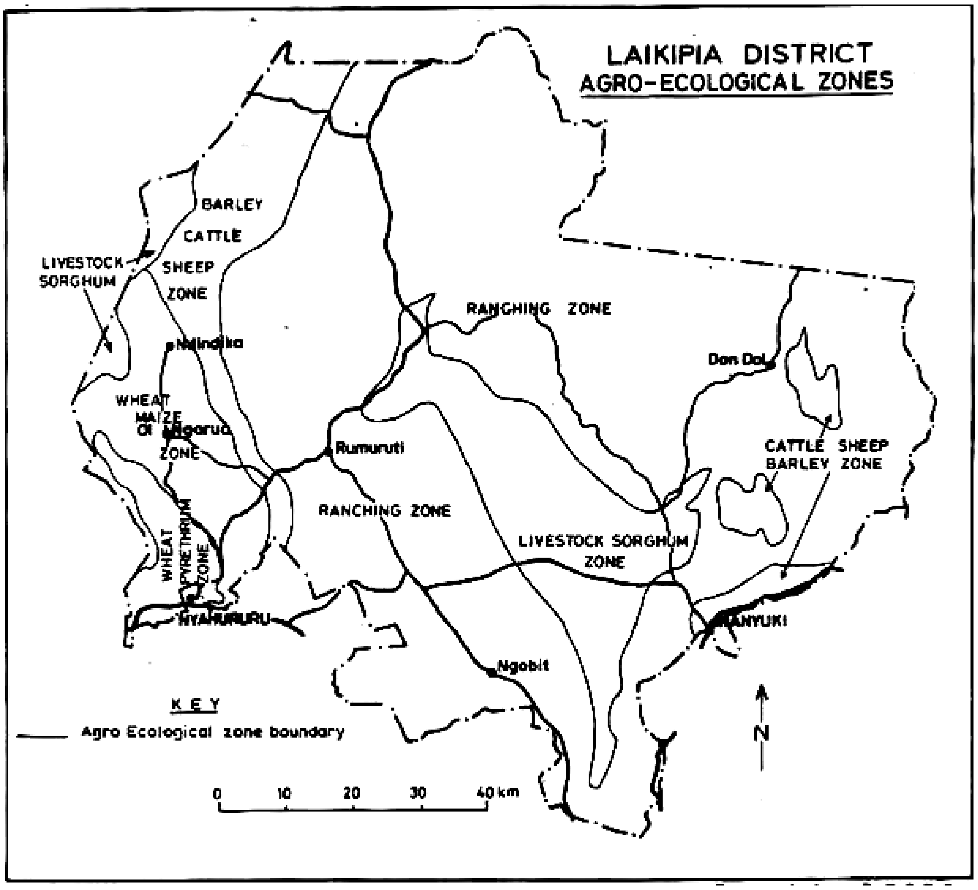
By 2001, land demarcation and registration had already started in Mbita division but no title deeds had been issued. In other divisions, particularly Gwassi and Central divisions, the process of registration was still at initial stages. Lambwe division is mainly a Government settlement scheme. Land disputes are being experienced in some divisions as people from other areas continue to settle in the area.

A reconnaissance study undertaken in February 2002 found out that Gwassi division had suitable characteristics for the study. The division had 5 locations, namely Gwassi Central, West, East, South and North locations and 15 sub-locations. It also had the three land tenure systems; on top of the hill was the trust land with disturbed forest and some people already settled; large parts of the land was demarcated with individual ownership although only about 1% was already registered. Land leasing was found in Samba sub-location while what can loosely be termed as communal lands were found in areas left for public utilities.

3.3.2 Laikipia

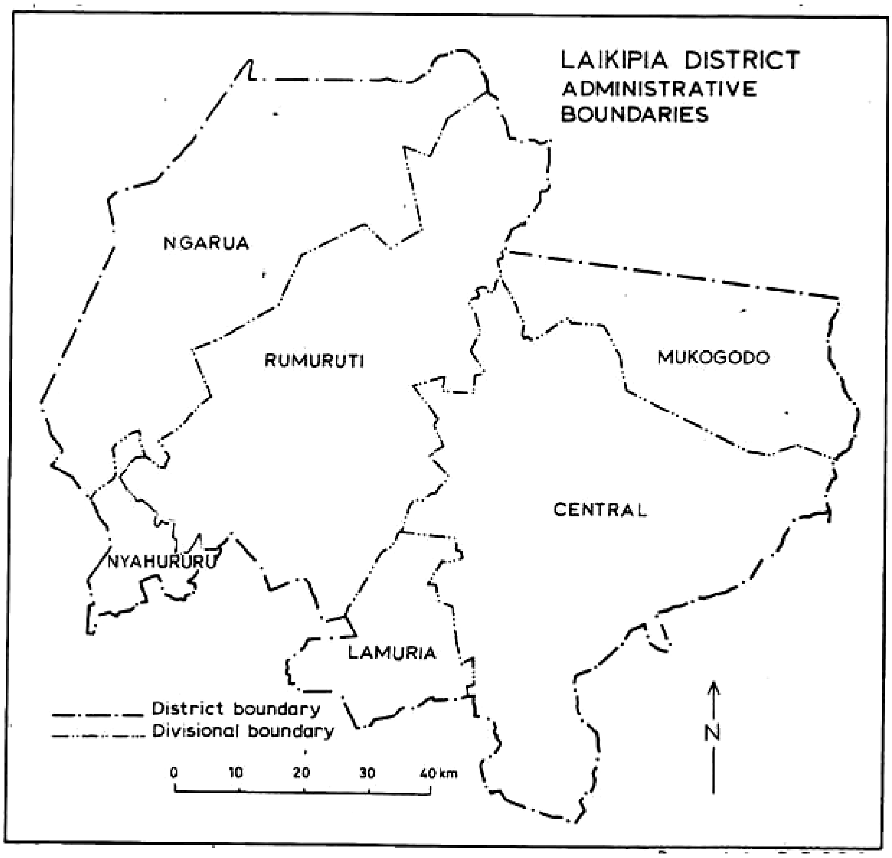
Laikipia district covers an area of 9,723 km^2 and is divided into seven divisions with 34 administrative locations and 64 sub-locations. The southwestern part of the district is the most densely settled. About 70 percent of the total population of 322,500 persons is concentrated in Rumuruti, Central and Ng'arua divisions. The three divisions have the highest potential for forestry and mixed farming due to their high altitude. The area mainly consists of an elevated plateau covered by volcanic ashes.

Figure 6: Agro-ecological Zones Of Laikipia District



Most of the land in Rumuruti and Ng'arua divisions was purchased from the former white settlers and have since been sold to individuals, partnerships and groups (Figure 7). Ng'arua which was selected for the study has a population of 66,700 persons and a total area of 787 km^2 out of which 370 km^2 are the potential agricultural land with 270 km^2 under cultivation.

Figure 7: Administrative Boundaries of Laikipia District



3.4 Survey Design

The survey was undertaken in 4 sub-locations per district. These were randomly selected from a cluster of 10 sub-locations in each district. Each of these clusters had almost the same agro-ecological conditions. Stratification was undertaken to ensure that various levels of tenure security were captured in the final sample.

In Suba district, the survey was carried out in Gwassi division from where the four selected sub-locations were: Magunga and Samba in Gwassi Central location; Tonga in Gwassi West location; and Kibwer in Gwassi East location. In Laikipia, the selected sub-locations in Ng'arua Division were: Dimcom in Sipili location; Mwenje and Mithiga in Kinamba location; and Kiambogo in Gituamba location.

Within each sub-location, eight clusters were formed out of which four were randomly selected. This ensured that every part of the sub-location was given an equal chance of being included in the sample. In each of the selected clusters, a list of the household heads was compiled. A total of 40 respondents were then randomly selected from the aggregate list of farm families in each sub-location.

In the context of this study, a farm family (household) was defined as any family unit that has a parcel of land to cultivate. In polygamous families, therefore, the term 'household' was construed to mean a house of each of the wives that have been allocated parcels of land by the husband. This is in line with the customary tenure system where each of the wives is normally allocated parcels of land by the husband to cultivate. The same applied to sons who had been allocated parcels by their fathers to cultivate even though they still resided in their father's homestead. The list of household heads was computed based on this understanding.

3.5 Data Analysis

The main focus in this research is the relationship between land tenure security on one hand and productivity and environment on the other. The quantitative and qualitative data analyses were used.

3.5.1 Descriptive Data Analysis

Data collected was used to make various descriptive analysis and explain some of the variables in the econometric models. These include techniques such as mean, median, mode, frequency tables, Pearson Correlation Coefficient, Chi-Squared and graphical methods.

3.5.2 Econometric Model of agricultural productivity

To determine factors influencing agricultural or land productivity, an OLS model was used. Land productivity is the dependent variable:

$$Q = \psi(\varepsilon, s, g, e, f, L, \chi, cs, fe, st, dr, m)$$

where Q= land productivity in bags of maize per acre;
ε = environmental degradation (1=no problem to 5=very serious degradation);
s = land tenure security (1=no rights to 4=full rights);
g = gender of land user (1=male; 0=female);
e = level of education (1=no education to 5=university)
f = access to credit facilities (1=yes, 0=no);
L = size of landholding (acres);
χ = slope of land (1=flat to 3=sloppy);
cs= certified seed (1=yes, 0=no);
fe=fertilizer (1=yes, 0=no);
st = soil type (type)
dr = drainage development (1=yes, 0=no);
m = manure (1=yes, 0=no);

3.5.3 Model of Environmental Degradation

In addition to the model of agricultural productivity, a Tobit Model was developed for environmental degradation. This model can be provided as:

$$D = \Omega(s, g, f, L, \chi, r, v, I)$$

where variable description is as above except for:
r= access to market (1=impassible to 4=very good);
v=vegetation cover (type);
I= average income of the household (annual); and
D = environmental degradation (1=none to 5=v. serious)

3.5.4 Model of Investment in Land Improvement (Conservation)

In order to establish the main determinants of investment in land improvement or environmental conservation, a Logit model was developed. This was due to the dummy nature of the dependent variables. The main land improvement methods such as terracing, drainage development, agro-forestry, tree crops and stump removal were considered. The dependent variables included sex of the land user; income level of the household; parcel size; soil type; existence of labour constraint; education level of the land user; main occupation of the land user; and existence of title deed.

4.0 RESULTS AND DISCUSSIONS

4.1 Basic Findings

4.1.1 Household Characteristics

The study undertaken in Suba and Laikipia districts with a sample size of 310, (150 from Suba and 160 from Laikipia), showed that about 52 percent of the households were headed by monogamous males, 23 percent were headed by polygamous males and 22 percent by female. It was also noted that about 74 percent of the female heads of households were widowed. The average family size was 5 children, with the maximum of 17.

4.1.2 Tenure System

Only 3 percent of the respondents occupied communally owned land, about one percent occupied state land and the rest were under individual tenure system (Table 2).

Table 2: Tenure System versus Agricultural Productivity

Count (%)	Maize yield in bags per acre				
Tenure System	**0-5.0**	**5.1-10.0**	**10.1-15.0**	**15.1-20.0**	**> 20.0**
Individual	143 (46.1%)	65 (21%)	39 (12.6%)	28 (9.0%)	2 (0.6%)
Communal		8 (2.6%)	1 (0.3%)		
State land		2 (0.6%)			

NB: figures in parentheses are % of total number of respondents (households)

4.1.3 Security of Tenure.

The problem associated with land ownership and tenure security was found to be serious in both districts, with 10 percent of the respondents being involved in recent land disputes. An analysis of land improvement revealed that some of these, particularly agro-forestry and tree crops, were closely related to land registration (Table 3). About three-quarters of households whose lands had been registered practiced agro-forestry while nearly 60 percent had tree crops. Among farmers whose lands had not been registered, only 47 percent practiced agro-forestry and 36 percent had tree crops. Increased tenure security likely stimulated landowners to invest in environmental conservation.

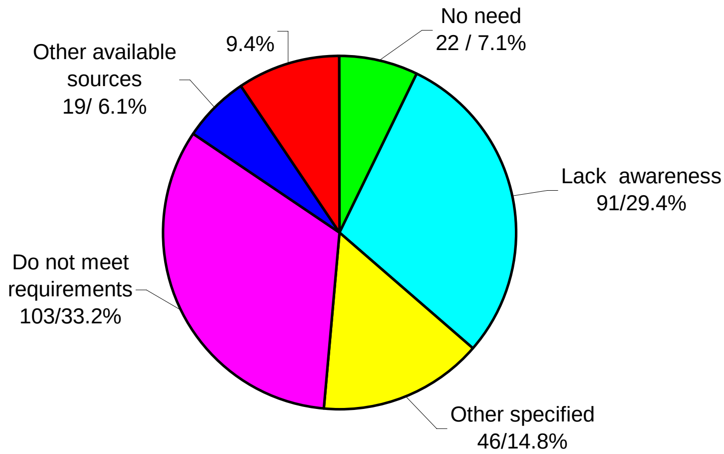
Table 3: Crosstab Analysis for Land Registration and Some Conservation Methods

Count (%	Land Registered			Total
Agroforestry Practiced		Yes	No	
	8 (66.7%)	1 (0.4%)		9 (2.9%)
Yes	1 (8.3%)	175 (75.4%)	31 (47%)	207 (66.8%)
No	3 (25%)	56 (24.1%)	35 (53%)	94 (30.3%)
Total	12 (100%)	232 (100%)	66 (100%)	310 (100.0%)*
Pearson Chi-square 201.73, significance of 0.00000%				
Coun	Land Registered			
Tree crops planting		Yes	No	
	8 (66.7%)	1 (0.4%)		9 (2.9%)
Yes	1 (8.3%)	133 (57.3%)	24 (36.4%)	158 (51.0%)
No	3 (25%)	98 (42.2%)	42 (63.6%)	143 (46.1%)
Total	12 (100%)	232 (100%)	66 (100%)	310 (100.0%)*
Pearson Chi-square 190.04, significance of 0.00000%				

4.1.4 Access to credit

The study revealed that only 6.1 percent of the respondents had received credit facilities while the rest gave various reasons for not having received or applied for loans. About 33 percent of the respondents had not applied because they could not meet the lender's requirements while 29 percent argued that they were not aware of the availability of the credit facilities. Another 15 percent gave other reasons that were not specified in the questionnaire (Figure 8). Prominent among these was fear of the land being auctioned if title deed was used as collateral.

Figure 8: Reasons for not applying for the loan



The survey revealed that no household used the title deed as collateral. The main collateral was group guarantee and co-signature that accounted for 80 percent of collaterals used. Indeed the relationship between title deed and access to credit had a Correlation Coefficient of 0.0626, which was not significant even at 10 percent level. (Annex 1). This in effect, downplays the importance of title deed in securing of credit facilities and shows the importance of group lending systems.

The study showed that only 2.3 percent of women land users applied for and received credit facilities as compared to 12 percent or their male counterparts (Table 4). This was attributed to lack of awareness and failure to meet the requirements such as collateral and other forms of security required by the financial institutions.

Table 4: Gender Access to Credit Facilities

Count (%)	Sex of land user	
Applied/received loan	Female	Male
Yes	2 (2.3%)	17 (12%)
No	84 (97.7%)	125 (88%)
	86 (100%)	142 (100%)
Chi-square 42.12, significance level of 0.00000		

Access to credit was relatively lower in Suba where only 2.7 percent of the respondents acquired loans compared to 9.4 percent in Laikipia. In both districts, most of those who acquired loans never used them for agricultural developments but for educating children and other non-farm activities. Out of the 19 farmers who received credit facilities, 47 percent used the funds on education of children, 16 percent for non-farm business and 37 percent for purchase of farm inputs.

4.1.5 Household income

The average annual income level for the household was estimated at Kshs. 33,000 with the minimum and maximum being Kshs. 3,000 and over 200,000 respectively. However, up to 80 percent of the households had no more than Kshs. 30,000 per annum and the mode was Kshs. 15,000 thus showing the level of skewness of the income.

4.1.6 Gender

Most household heads were men. In Suba district, 81 percent of the households were headed by men as compared to 76 percent in Laikipia. However, the majority of land users in Suba (60 percent) were women. In Suba, most men undertake non-farm activities or work in urban areas thereby leaving women to undertake farming. In Laikipia, farming is taken as a business and is regarded by men as a paying occupation and thus the majority are farmers.

4.1.7 Access to Market

The average distance to the input and product market was estimated at 3.5 and 122 km for the nearest urban market. 28 percent of farmers lived within 2 km radius of the market. Road conditions were generally poor, affecting agricultural production and development. 66 percent of the farmers considered their roads to the market as impassable, constraining access to the markets during the rainy season. Consequently, commodity prices were low due to inaccessibility to markets and exploitation by middlemen. This was particularly serious in Laikipia where maize prices plunged to Kshs. 400 per bag within a short period.

4.1.8 Labour

Most (58 percent) farmers have sufficient family labour (Figure 9), while most indicated availability of adequate hired labour (Figure 10). This is contrary to initial assumption that farmers face labour constraints, especially during weeding and harvesting.

Figure 9: Household Labour Constraints

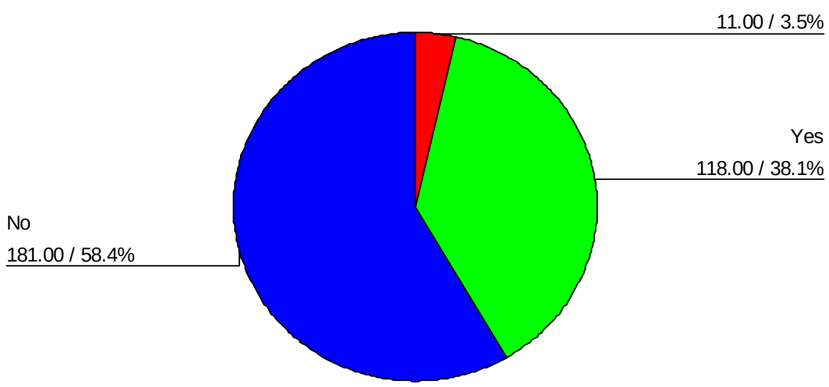
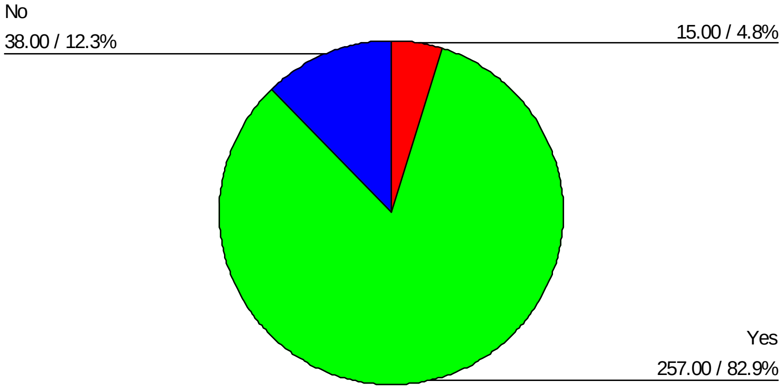


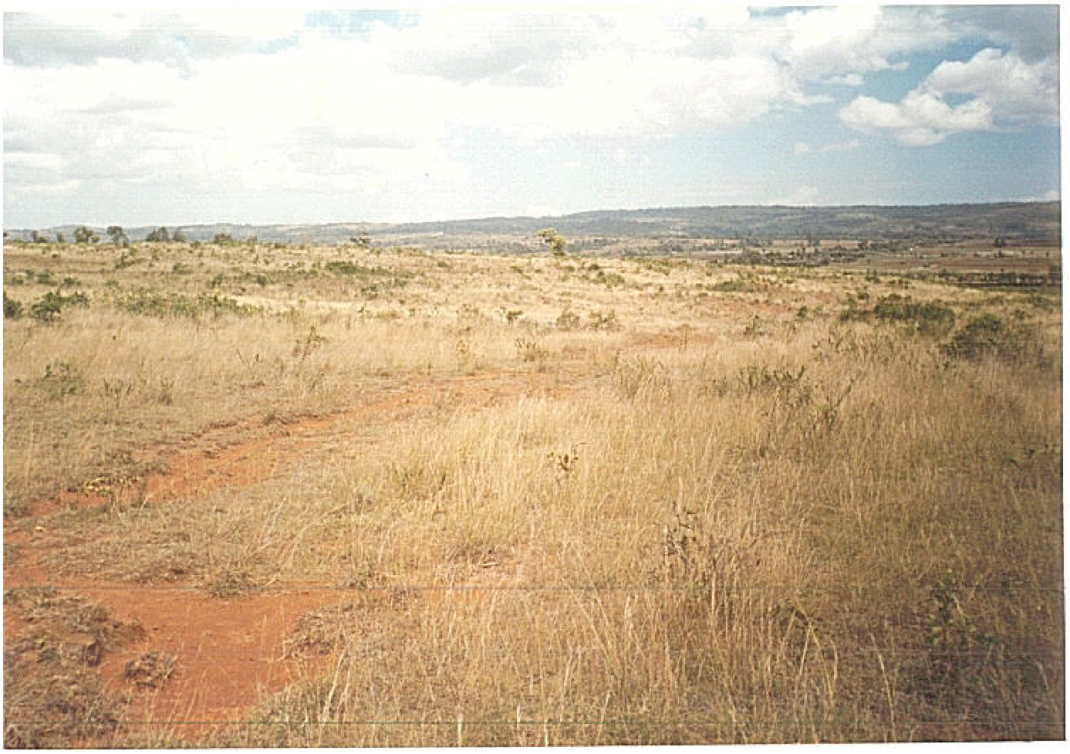
Figure 10: Availability of hired labour



4.1.9 Environmental Conditions

Environmental degradation was reported in both districts. Following massive forest clearance and intensive agricultural activities in Laikipia, the ground water levels had dropped by at least 10 feet. Previously forested land was under shrubs (Figure 11). Without addressing this problem, the region could experience serious climate change that would affect agricultural production and the ecosystem.

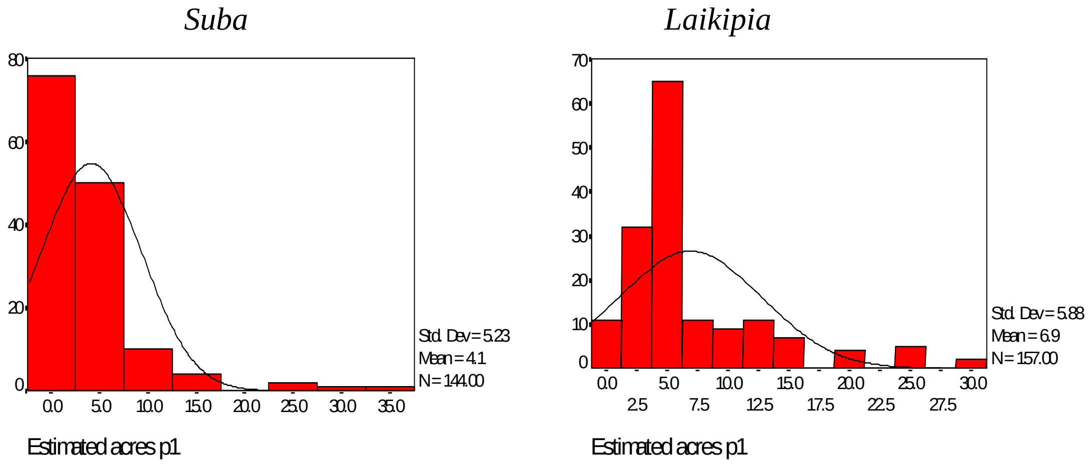
Figure 11: Environmental Degradation in Laikipia District



4.1.10 Farm Sizes

The two districts had different average farm sizes, with Laikipia having relatively larger farms averaging 7.5 acres compared to Suba's 4.1 acres. The average farm size for both districts was 5.9 acres. The modal farm sizes were 5 acres for Laikipia and 2 acres for Suba, with greater skewness towards zero in the case of Suba (Figure 12).

Figure 12: Distribution of Land Sizes in Suba and Laikipia Districts



The main source of access to land is through inheritance, with about half of the responding obtaining land through inheritance while 22 percent purchased the land. About 12 percent of the respondents acquired land through government settlement while about one percent were squatters. Land subdivision is common in both regions, with 57 percent of the land parcels in Suba having been subdivided within the last few years. In Laikipia, about 20 percent of the parcels were subdivided recently.

4.1.11 Land Productivity

Most farms in Suba and Laikipia have been farmed for a long period of time, leading to productivity decline. Two thirds of the respondents said their land productivity had declined. Only 28 percent of respondents reported productivity increases. About 63 of those whose land productivity declined were from Laikipia district, where a relatively higher proportion of land was under cultivation all year round (Table 5). About 60 percent of the respondents in Laikipia had at least 70 percent of their land under cultivation.

Table 5: Status of Productivity over the years

Value	Frequency	Percentage
Constant	5	1.6
Decreasing	205	66.1
Increasing	88	28.4
No answer	12	3.9
Total	310	100.0

Figure 13 shows the level of cultivation in Laikipia district with trees being planted mainly around the homesteads while farms remain without any trees.

Figure 13: Land Cultivation in Laikipia

It is evident from Table 6 that productivity has been dropping more on larger farms than smaller ones. One would observe that cells for larger farms have mostly been experiencing productivity declines with very few of them registering productivity increases. Farmers who reported increase in land productivity were mainly those with smaller farms. They confirmed having kept productivity stable through use of fertilizer and manure.

Table 6: Crosstab Analysis of Parcel Size and Land Productivity Over Time

(%)	Parcel Size (in acres)							
Land Productivity	**0-1.0**	**1.1-2.0**	**2.1-4.0**	**4.1-6.0**	**6.1-10.0**	**10.1-15.0**	**15.1-25.0**	**> 25.0**
Constant	5%	2%	2%	-	3%	-	-	-
Decreased	67%	56%	57%	75%	90%	72%	82%	75%
Increased	28%	42%	41%	25%	7%	28%	18%	25%

4.1.12 Education

Bivariate analysis showed a significant relationship between education and both use of improved farm inputs and land productivity. Correlation coefficient showed that educated farmers are more likely to use fertilizer and certified seed than their less educated counterparts (Annex 1). Similar results were derived from Cross-tab analysis. Table 7 shows that 78 percent of farmers with a college degree applied fertilizer. The comparable figures for application of certified seed for college graduates were 83 percent.

Table 7: Crosstab Analysis for Education and Input Use

Count (%)	Education Level of the Land User					Total
Fertilizer Usage	None	Primary	Secondary	College	University	
No	53 (78.8%)	116 (71.6%)	21 (55.3%)	4 (22.2%)	-	194 (66.9%)
Yes	16 (23.2%)	46 (28.4%)	17 (44.7%)	14 (77.8%)	3 (100%)	96 (33.1%)
Pearson Chi-square 29.29192 - significance level of 0%						
Certified Seed Usage	None	Primary	Secondary	College	University	
No	57 (82.6%)	123 (75%)	26 (68.4%)	3 (16.7%)	-	209 (71.6%)
Yes	12 (17.4%)	41 (25%)	12 (31.6%)	15 (83.3%)	3 (100%)	83 (28.4%)
Pearson Chi-square 39.48855 - significance level of 0%						

Two-variable analysis showed that there were statistical variations between the two study districts. This was further confirmed by the Chow test on seven key variables that influence maize yield. The test yielded F-statistic of 12.56, which was significant at 1 percent level meaning that there were significant variations in data between the two districts. It was therefore necessary to use dummy variables to capture these regional differences (Table 8).

4.2 Econometric Models for Agricultural Productivity

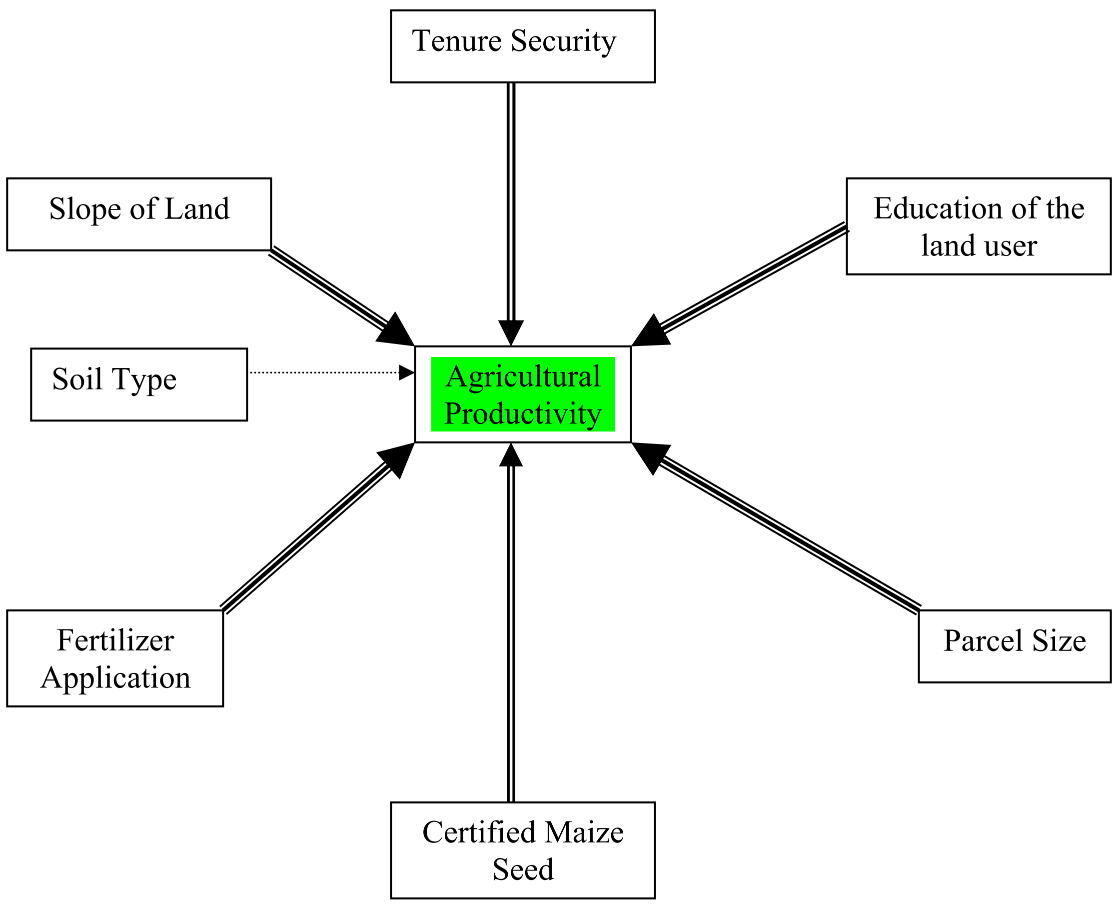
The regression analysis model described in section 3.6.2, with maize yield as the dependent variable, was run in three versions. First model or Model 1 (Table 8) had a number of explanatory variables. These include land tenure security, parcel size, level of environmental degradation, education, sex, slope, use of certified seed and fertilizer application, soil type, drainage development and application of manure. These factors, in conjunction with the dummy variables representing various sub-locations explained up to 60 percent of the variations in the maize yields. In order to come up with a reduced form model, explanatory variables were eliminated one by one based on their levels of significance.

Model 2 is similar to Model 1, except the exclusion of sex and drainage development. The most preferred model, Model 3, has two other variables missing: manure and environmental degradation. A number of other variables that could have caused simultaneity bias were also dropped at the initial stages. Except for soil type, all the other variables in the reduced form equation had significance level of at most, 10 percent. A joint significance test on the 4 dropped variables yielded F-Statistic of 0.296, which is insignificant at 10% level meaning that the four variables are not jointly significant and as such, we lost nothing by dropping them.

It is notable that the dummy variables for Laikipia (D1-D4) and those for Suba (D5-D7) differ substantially. It was observed that the regional dummies for Laikipia were positive while those for Suba were negative. This in essence indicates the wide variation of maize yields between the two districts with those for Suba being substantially lower, and hence the negative dummy. In the next sections, we are going to examine some of the relationships that were derived from this model.

Figure 14 shows the relative strengths of the relationships between agricultural productivity and some of its determinants that were considered in this study. It shows that productivity was more strongly related to education level of the land user and the slope of land than all the other determinants. Both were significant at 5 percent level. The detailed outcome of the regression is as in Table 8.

Figure 14: Key factors influencing agricultural productivity



Models 4 and 5 were district specific versions of Model 1, which have also been reduced to minimize possibility of misspecification. The results in both districts concur for variables such as: environmental degradation; education of the land user; slope of land; sex of land user and drainage development. However, some of the results exhibit significant regional variations. These include tenure security, parcel size and input usage. We look at these in more detail in the next sections.

4.2.1 Tenure Security (S)

The study found a positive relationship between agriculture productivity and tenure security (Table 8) thus agreeing with our null hypothesis that "land productivity is directly and positively related to land tenure security". This security was determined based on land rights such as: the right to sell land; plant and cut trees; designate heir to the land; plant annual crops; plant perennial crops; and rent out land. The results show that farmers who have more of these rights achieve relatively higher yields than those who do not have.

Table 8: Regression Results on Maize Productivity

	Model 1	Model 2	Model 3	Model 4 Laikipia	Model 5 Suba
Constant	-1.7193 (1.6724)[a]	-1.7280 (1.6664)	-2.0684 (1.6066)	0.90888 (1.9066)	-1.1783 (1.1575)
Tenure Security (S)	0.46698** (0.21871)	0.46756** (0.21738)	0.45356** (0.21619)	0.54863 (0.38470)	0.45992*** (0.15415)
Parcel size (L)	-0.10346*** (0.035606)	-0.10310*** (0.035452)	-0.099676*** (0.035102)	-0.14348*** (0.056728)	-0.35541 (0.29557)
Environmental degradation (ε)	-0.22678 (0.28606)	-0.22236 (0.28424)	-	-	-
Education level of the land user (E)	0.84399*** (0.28852)	0.84093*** (0.28147)	0.79687*** (0.27472)	0.97637** (0.46289)	0.54780** (0.21959)
Sex of land user (λ)	-0.080372 (0.52154)	-	-	-	-
Slope of land (χ)	1.1364*** (0.36012)	1.11314*** (0.35824)	1.0390*** (0.34373)	1.7445*** (0.65483)	0.70936*** (0.24254)
Certified Maize Seed (cs)	1.3859** (0.63766)	1.3654** (0.63116)	1.4495** (0.61935)	2.0273** (1.0226)	-
Fertilizer application (fer)	1.9527*** (0.75108)	1.9559*** (0.74841)	2.0048*** (0.74130)	1.9889* (1.0201)	-2.4356 (1.9603)
Soil Type (st)	0.39868 (0.34634)	0.40314 (0.34476)	0.42264 (0.34296)	-	0.42769* (0.25579)
Drainage development (dr)	0.14953 (0.64058)	-	-	-	-
Manure application (m)	0.47568 (0.64058)	0.46468 (0.63986)	-	-	3.1603*** (1.1230)
Mwenje sub- location (D1)	4.4639*** (1.0495)	4.4763*** (1.0014)	4.5946*** (0.99217)	0.86170 (1.1306)	-
Mithiga sub location (D2)	7.3127*** (1.1596)	7.2665*** (1.1183)	7.4874*** (1.0516)	4.1629*** (1.1449)	-
Kiambogo sub-location (D3)	5.4165*** (1.0611)	5.3635*** (1.0176)	5.4383*** (0.98545)	2.5223** (1.2477)	-
Dimcom sub-location (D4)	3.2273*** (1.1244)	3.2049*** (1.0807)	3.4461*** (1.0151)	-	-
Kibwer sub-location (D5)	-1.6144 (1.0568)	-1.6640* (1.0021)	-1.7652* (0.98491)	-	-1.6452*** (0.55783)
Magunga sub-location (D6)	-0.82505 (0.96788)	-0.84230 (0.96036)	-0.84655 (0.95730)	-	-0.90940* (0.53794)
Tonga sub-location (D7)	-1.1400 (1.0656)	-1.11235 (1.0356)	-1.2136 (1.0248)	-	-1.4509** (0.61129)
R-Squared	0.604853	0.604748	0.603244	0.310037	0.292131
F-Statistic	24.746	28.019	32.038	7.4892	5.1774
N	310	310	310	160	150

Where: [a] = Figures in parentheses are standard errors
* = Coefficient significant at 10 percent level
** = Coefficient significant at 5 percent level
*** = Coefficient significant at 1 percent level

A closer sectional analysis in Models 4 and 5 revealed that the relationship was more significant in Suba than in Laikipia district. This is due to the difference in the characteristics of the two districts. First, land registration in Laikipia was completed in the 1980s while in Suba the registration is still ongoing. With registration complete, the main avenue for tenure insecurity in Laikipia could be usage of land by wives, sons or lessees who may not be having the full rights to the land whereas in Suba, besides these factors, there are farm families whose land have not been registered and therefore have no incentive to invest in land improvement.

Household characteristics and cultural differences between the two districts may also play a part in making tenure security to influence agricultural productivity more significant in Suba than in Laikipia district. It was established that about 37 percent of households in Suba are polygamous with women being the main land users (60 percent). This is far much higher than 12 percent recorded in Laikipia district where men are the main land users (71 percent). The foregoing therefore means that land insecurity is higher in Suba than in Laikipia and hence the difference in responsiveness of productivity to tenure security.

4.2.2 Farm Sizes (L)

The study showed that agricultural productivity is higher on smaller farms than on larger (Table 8). This was significant at 1 percent and was attributed to smaller farms being more intensively used particularly in Laikipia with more application of fertilizer and manure. Regional analysis however indicated that the relationship between land productivity and farm size was highly significant in Laikipia district but insignificant in Suba (Model 4 and 5). This is mainly due to minimal usage of fertilizer in Suba as opposed to Laikipia and the fact that land in Suba has not been exhausted as some areas were still left fallow.

4.2.3 Environmental degradation (ε)

The study did not find any significant relationship between environmental degradation and maize yield. This was consistent in all study areas. Although the perceived relationship had a negative sign in all areas, being insignificant makes it difficult to convince farmers about the importance of averting land degradation.

4.2.4 Education Level of the land user (E)

A significant positive relationship was established between agricultural productivity and education level of the land user meaning that the higher the education level of the land user, the higher the expected crop yield (Table 8). This is because education of the land user tends to be positively linked to usage of productivity enhancing inputs such as fertilizer and certified seeds besides adoption of better crop husbandry as was evident in section 4.1.12.

4.2.5 Sex of the land user (λ)

No significant relationship was established between sex of the land user and productivity and this was consistent in all regions. This is important for Kenya because the majority of farmers are women who have been argued to be disadvantaged particularly in access to resources such as land, credit and even extension packages (MOALD 2003; FAO 2003b). The results show that these disadvantages have not tilted productivity in favor of men.

4.2.6 Slope of land (χ)

The close linkage established between agricultural productivity and the slope of land parcel prompted the research team to look into the possible reasons for the relationship more so because the result was consistent in both Suba and Laikipia districts. Land slope was classified into three categories: flat, gentle (less than 15^0), and steep (more than 15^0). Flat lands covered about one-quarter of the land area while the gentle sloping and steep were 58 and 17 percent, respectively. Lower maize yields in flat lands might be because of poorly drained soils (clay) that are not suitable for maize production. Maize yields are higher on better-drained gently sloping lands.

4.2.7 Certified Seed (cs)

The study established a significant relationship between usage of certified seed and crop yields. This was particularly more significant in Laikipia where most farmers (about 60 percent) used certified seeds. However, the relationship was not significant in Suba where very few farmers (only about 6 percent) used certified seeds with the rest using locally available materials.

4.2.8 Fertilizer and manure application (fer & m)

A strong positive relationship was established between crop yield and usage of fertilizer. However, the results were not consistent across the regions. The relationship was strong in Laikipia but insignificant in Suba. This was due to differences in soil types and minimal usage of fertilizer in Suba as opposed to Laikipia. It was also established that in Suba, those who apply fertilizer rarely apply in recommended quantities and thus reducing its effect on maize yields.

The study established a significant relationship between application of manure and crop yields in Suba district. The fact that this was significant at 1 percent means that farmers in this region depend more on manure and less on fertilizer. This contrasts much with Laikipia where the relationship between manure and yield is insignificant (Table 8).

4.2.9 Soil Type (st)

In overall, there was no significant relationship between soil type and crop yields. However, a cross sectional analysis indicates that in some regions such as Suba, soil type may influence crop yields. The relationship was found to be significant at 10 percent level in Suba but insignificant in Laikipia and the two districts combined. The level of significance seems to depend on the variety of soil types found in the region whereby in Suba there are two contrasting soil types – well drained and nutrient rich phaeozems versus the poorly drained nutrient poor vertisols.

4.3 Econometric Models for environmental degradation

The study team undertook a Tobit analysis to establish linkages between environmental degradation and other variables such as gender, credit, and tenure security. This was adopted due to the discrete nature of the dependent variable and existence of non-responses that called for data censoring. For regional comparison purposes, separate regressions were run for both Suba and Laikipia districts in addition to that for the two districts combined. The results of this regression are as summarized in Table 9.

The study did not establish any significant relationship between tenure security and environmental degradation. This was even confirmed by the various components of tenure security such as rights to sell land, designate heir to land, plant and cut trees, and so on.

No significant relationship was also established between environmental degradation and tenure security acquired through title deed (Table 8). This means that improving on tenure security alone will not stimulate farmers to control environmental degradation.

As expected, a very strong negative link was established between vegetation cover and environmental degradation. This calls for curbing of wanton clearance of vegetation and leaving the land bare that would increase chances of increased environmental degradation. It also showed that although there is a significant negative relationship between agroforestry / tree crops and environmental degradation, these alone cannot effectively control environmental degradation, hence the relatively weaker relationships.

The results also showed a positive link between slope of land and environmental degradation, with higher rates of degradation being observed on steeper slopes. This confirms the close linkage between slope of land and rate of soil erosion. Exposure of land on the steeper slopes would therefore lead to more devastating rates of erosion assuming other factors are held constant.

The strong negative link established between access to the market and environmental degradation could be said to be an association rather than causality. However, one would argue that better road condition and hence ease of access to the market would encourage a farmer to invest in environmental conservation in an attempt to rip the maximum benefit out of the land. As expected, soil type came out to be one of the key factors determining the rate of environmental degradation. This relationship was significant at 10 percent level.

Table 9: Tobit Analysis with Environmental Degradation as the dependent variable [a]

Variable	Laikipia	Suba	The districts combined
Sex of land user	-0.0278 (0.1253)	0.2691 (0.1673)	0.0217 (0.1038)
Income of land user	-0.0025 (0.0016)	0.0018 (0.0027)	-0.0012 (0.0014)
Parcel size	0.0105 (0.0099)	0.0195 (0.0199)	0.0146 (0.0096)
Gradient of land	0.042 (0.0917)	0.4129*** (0.1307)	0.2051*** (0.0786)
Vegetation cover (%)	-0.0165*** (0.0031)	-0.015*** (0.004)	-0.0152*** (0.0024)
Access to market	-0.276*** (0.077)	-0.1599 (0.1072)	-0.2805*** (0.0648)
Tenure security	0.0168 (0.0689)	0.1953 (0.1445)	0.0389 (0.0683)
Access to credit	0.0884 (0.2228)	-0.4114 (0.5239)	-0.0687 (0.2208)
Soil type	-0.0062 (0.0688)	-0.1771 (0.1158)	-0.1132* (0.062)
Right to sell land	-0.033 (0.082)	0.0204 (0.1273)	0.0946 (0.059)
Right to designate heir to land	-0.003 (0.0759)	-0.2574 (0.1664)	-0.0778 (0.078)
Right to rent out land	-0.0667 (0.0826)	-0.0019 (0.1421)	-0.111 (0.0762)
Right to plant and cut trees	-0.0398 (0.0794)	0.1574 (0.2945)	0.0387 (0.0796)
Right to plant perennial crops	-0.0006 (0.1139)	0.2378 (0.3446)	0.0944 (0.1103)
Agroforestry (1=yes)	-0.3977* (0.2321)	0.0444 (0.1714)	0.0056 (0.1301)
Tree Crops (1=yes)	-0.095 (0.1646)	-0.2855 (0.1477)	-0.3637*** (0.1154)
Education level of land user	-0.0273 (0.0756)	0.0379 (0.1477)	-0.0158 (0.0738)
Farming is main occupation of land user (1=yes)	-0.0789 (0.1327)	-0.4235 (0.2689)	-0.1003 (0.1348)
Title deed (1=yes)	0.2141 (0.1477)	0.0216 (0.2943)	0.0763 (0.1376)
Constant	4.474*** (0.61367)	2.3173** (0.9457)	3.862*** (0.535)
Log Likelihood	-111.13	-145.48	-281.04
Number of relevant observations	129	124	253

Where: [a] Numbers in parentheses are standard errors.
* Significant at 10%, ** significant at 5%, *** significant at 1%.

4.4 Econometric Models for Environmental Conservation

In an attempt to establish the determinants of investment in environmental conservation and other forms of land improvement, we used logit regression analysis and the results are as in Table 10. The choice of the model was based on the binomial nature of the dependent variables. The total number of valid observations was 250. The main land improvement methods were expressed as dummies and included terracing, drainage development, agroforestry, tree crops and stump removal. These factors, except for the latter are also key determinants of environmental conservation.

It is evident from the results that there was a significant relationship between drainage development and tenure security. However, no significant linkage was established between tenure security and investment in the other land improvement or environmental conservation methods. Tenure security through acquisition of title deed strongly stimulates investment in agroforestry, tree crops and stump removal, as the relationship was significant at 1 percent level. Income of the household head tends to influence investment in environmental conservation, especially through agro-forestry and tree planting. This would therefore mean that by emphasizing on the fight against poverty, environmental conservation will be enhanced.

Table 10: Logit regression of factors influencing investment in land improvement [a]

Variable	Terracing	Drainage	Agroforestry	Tree crops	Stump removal
Sex of land user (1=male)	-0.21267 (0.30085)	0.22302 (0.38246)	0.27883 (0.37433)	0.16009 (0.30473)	1.15115*** (0.3123)
Income of household head	0.00222 (0.004)	-0.0055 (0.00518)	0.03427*** (0.00832)	0.01287*** (0.00488)	-0.00136 (0.00455)
Parcel size (acres)	0.0187 (0.27422)	0.02277 (0.03324)	-0.00853 (0.04831)	0.02777 (0.03136)	0.05144 (0.0317)
Gradient of land	0.24312 (0.22462)	-0.51685* (0.2918)	0.96589*** (0.30721)	0.20771 (0.23684)	-0.47593* (0.24343)
Access to market	-0.38745** (0.18488)	-0.13652 (0.24432)	0.32606 (0.21005)	-0.26796 (0.18288)	-0.32057* (0.19307)
Tenure security	0.18875 (0.13084)	0.4184** (0.18715)	0.01103 (0.16498)	-0.17443 (0.13279)	0.20407 (0.13672)
Access to credit	0.51879 (0.632)	0.70015 (0.72784)	-0.85345 (0.85962)	0.31858 (0.78781)	1.54302 (1.1175)
Soil type	0.19798 (0.17595)	-0.15531 (0.22421)	0.87207*** (0.23868)	0.03875 (0.18407)	-0.06747 (0.19147)
Labour constraint (1=yes)	-0.09704 (0.29508)	0.10431 (0.36137)	-0.59187 (0.36681)	-0.64653** (0.30426)	0.59338* (0.31318)
Education level of land user	0.33466 (0.21376)	0.30013 (0.25553)	-0.72** (0.29407)	0.14087 (0.22528)	0.04824 (0.2433)
Farming is main occupation (1=yes)	0.49533 (0.40922)	0.454067 (0.53412)	-0.74896 (0.60822)	-0.19303 (0.43201)	-0.38624 (0.43907)
Title deed (1=yes)	-0.16075 (0.3386)	0.0672 (0.43181)	2.6369*** (0.56935)	1.40492*** (0.35733)	1.07374*** (0.36685)
Constant	-2.05768* (1.2052)	-2.1764 (1.5333)	2.63692*** (0.56935)	-0.13832 (1.2658)	0.68552 (1.3137)
Log likelihood	-155.54	-109.15	-103.25	-147.02	-414.36

[a] Numbers in parentheses are standard errors.
* indicates significance at 10% level
** indicates significance at 5% level
*** indicates significance at 1% level

5.0 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Land Tenure Security

This study confirms the importance of land tenure security effects on agricultural productivity. Sustainable agricultural development cannot be achieved without considering land tenure security. Increased tenure security is needed to stimulate environmental conservation. It is crucial for government to lay emphasis on enhancing land tenure security through land adjudication, registration and issuance of title deeds, and through strengthening appropriate policy and legal framework. A land use policy is needed that will enhance investments in land improvement and sustainable use of land. Such a policy should cover and give incentives to leasers of land as well.

5.2 Environmental Degradation

This study did not establish any significant relationship between environmental degradation and land productivity. However, some descriptive analysis showed that productivity has been dropping in both districts over time and this was partly attributed to environmental degradation. It also showed that indiscriminate exploitation of the environment resulted in sinking ground water table and reduced volume of rainfall per year in Laikipia district.

The foregoing confirms the long-term nature of environmental degradation and how difficult it is to disentangle the effect of degradation on crop yields, especially in the short run. This is made even more difficult when the effects are masked by application of fertilizer, manure and higher yielding seed varieties.

As any other investor, farmers would only start taking conservation seriously after realizing some consequences of degradation. However, some farmers may take note of the consequences of degradation too late when the land is already degraded to the extent that it will take too long or massive resources to return it to its original state. It should therefore be emphasized to farmers and other land users that development of any land should go hand-in-hand with environmental conservation. Farmers should thus be enlightened through aggressive extension and campaigns. Exchange visits to places suffering from advanced environmental degradation versus those, which have conserved the environment, should be promoted. This will make them visualize the consequences of delayed soil conservation and make them see the need to take appropriate measures before notable degradation is registered.

In order to achieve sustainable development, there is need to intensify the campaign for environmental conservation through activities such as tree planting with the aim of increasing vegetation cover. In areas where agroforestry may not be feasible due to use of heavy machinery in cultivation and/or harvesting, woodlots and fruit-trees may be adopted to increase vegetation cover. Besides vegetation cover, measures that ensure retention of water in the soil should be promoted. These include mulching, composting, water harvesting among others.

5.3 Land Productivity

The survey revealed that in Suba, productivity was far much lower than that of Laikipia district - averaging 2.5 bags per acre as compared to 10.7 bags in Laikipia and the national average of 9 bags per acre. The yields varied from 0 to 10 bags per acre in Suba and 2 to 23 bags per acre in Laikipia. The low yields in Suba were mainly blamed on non-use of certified seeds and fertilizer besides the effect of striga (witch) weed. The low yields have direct impact on food security and poverty levels and could be a pointer to the level of extension service delivery.

In order to achieve the national objective of poverty reduction, there is need to strengthen extension service delivery, particularly in the districts that have high agricultural potential but register extremely low agricultural productivity. The extension staff should endeavor to establish the reasons for the low yields, provide farmers with alternative options and help them decide on which farming enterprises to go for, based on the gross margin and market targeting. Farmers should also be enlightened on the importance of adopting usage of certified seeds, fertilizer and manure.

The fight against the parasitic weeds should also be stepped up in all the districts where they pose a problem. As researchers and extension staff look for a lasting solution to the weed, the study hopes that promotion of manure application will go a long way in addressing the problem of striga weed and improve the crop yields.

Farmers in Suba district confirmed that tsetse infestation wiped out their oxen used for ploughing thereby seriously affecting land preparation. This reportedly resulted in poor land preparation and is suspected to have affected crop yields. Concerted effort should be made to contain the tsetse infestation in the area. This should be done through mobilization of the local communities in these endeavors. Techniques such as the use of tsetse traps should be applied as researchers continue with their effort to come up with more effective and sustainable ways of controlling the fly. This calls for stepping up the efforts by research institutes dealing with Trypanosomiasis. Being a devastating problem in various parts of Africa, Kenya should work closely with neighbouring countries in controlling Trypanosomiasis.

5.4 Gender issues

The study established that women are more vulnerable to poverty than men and that this could be arising from gender inequality in terms of access to productive resources such as land and access to essential services such as education and extension packages. It is therefore necessary to formulate policies that will specifically go towards alleviating poverty of women. Gender mainstreaming is therefore important. It is also crucial to formulate policies that will address gender bias in access to productive resources such as credit and land. Parents should also be enlightened about the importance of educating children and particularly the girl child.

5.5 Access to Market

A number of factors relating to investment in soil conservation and low gross margins arise from poor access to the factor and product market. It is therefore of paramount importance to address issues relating to market access. This include establishment of an efficient market information system, establishment of farmer groups (cooperatives) that carry out marketing of both produce and input as well as providing farmers with some credit facilities. Management of these organizations should be streamlined and made more accountable to regain the confidence of farmers lost due to poor management in the past.

The study established that roads are key not just for market access but also investment in soil conservation as most farmers will not invest in land improvement if the produce will not reach the market or if the cost of transport is too high due to poor road status. The government should therefore take it upon itself to lay emphasis on improvement of rural road network that make the markets inaccessible and increase the transport costs thereby substantially reducing farmers' gross margins. Possibilities of actively involving the private sector and local communities in road maintenance should also be explored.

The importance of encouraging development of on-farm storage facilities cannot be overemphasized. With adequate and appropriate storage in place, seasonal fluctuation in the product prices will be reduced and farmers will not be forced to sell below the production cost as was evident in the study. Some of these storage technologies already exist and only need disseminating to farmers and traders. Where they exist but are idle, the National Cereals and Produce Board (NCPB) stores should be rent out to the farmer groups for grain storage. Other investors should also be encouraged to put up suitable storage facilities for hire by the farmer groups and traders.

5.6 Education

The study recognized the importance of education in poverty reduction through evident linkages between education and agricultural productivity and income of household head. The higher the education level of the land user the higher the level of agricultural productivity. It is therefore important for the Government to strengthen its efforts to ensure education for all, as this is paramount if increased agricultural productivity and thus poverty reduction is to be achieved.

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Annex 1: Pearson Correlation Coefficients

	CHILDED	CSEED1M	CULTD1	EDLUSER	ENVD1	FERT1M
CHILDED	1.0000	.1212	-.1066	.1049	-.0946	.3042
	(301)	(291)	(298)	(301)	(301)	(289)
	P= .	P= .039	P= .066	P= .069	P= .101	P= .000
CSEED1M	.1212	1.0000	-.0755	.3171	-.0657	.5021
	(291)	(292)	(289)	(292)	(292)	(290)
	P= .039	P= .	P= .201	P= .000	P= .263	P= .000
CULTD1	-.1066	-.0755	1.0000	.1470	.0222	-.0042
	(298)	(289)	(299)	(299)	(299)	(287)
	P= .066	P= .201	P= .	P= .011	P= .702	P= .943
EDLUSER	.1049	.3171	.1470	1.0000	-.0396	.2906
	(301)	(292)	(299)	(302)	(302)	(290)
	P= .069	P= .000	P= .011	P= .	P= .493	P= .000
ENVD1	-.0946	-.0657	.0222	-.0396	1.0000	-.2441
	(301)	(292)	(299)	(302)	(302)	(290)
	P= .101	P= .263	P= .702	P= .493	P= .	P= .000
FERT1M	.3042	.5021	-.0042	.2906	-.2441	1.0000
	(289)	(290)	(287)	(290)	(290)	(290)
	P= .000	P= .000	P= .943	P= .000	P= .000	P= .
INCOME	.2422	.3034	-.0009	.4068	-.0639	.2642
	(291)	(283)	(289)	(292)	(292)	(281)
	P= .000	P= .000	P= .988	P= .000	P= .276	P= .000
MAIZEYD	.2886	.3961	-.0241	.2576	-.2290	.6504
	(289)	(286)	(287)	(290)	(290)	(284)
	P= .000	P= .000	P= .685	P= .000	P= .000	P= .000
P1GRAD	.0399	.1128	-.3478	-.1598	.0916	.0700
	(300)	(291)	(298)	(301)	(301)	(289)
	P= .491	P= .055	P= .000	P= .005	P= .113	P= .236
P1L_REG	.1852	.2728	-.1422	-.0278	.0390	.3322
	(297)	(289)	(295)	(298)	(298)	(287)
	P= .001	P= .000	P= .014	P= .632	P= .503	P= .000
P1SIZE	.5050	.2952	-.4114	.0955	-.0991	.3096
	(300)	(291)	(298)	(301)	(301)	(289)
	P= .000	P= .000	P= .000	P= .098	P= .086	P= .000
P1TDEED	.2697	.3016	-.0668	.1013	-.2010	.4366
	(292)	(284)	(290)	(293)	(293)	(282)
	P= .000	P= .000	P= .257	P= .083	P= .001	P= .000
SEXHH	-.0577	.1623	-.0584	.2403	-.0589	.1019
	(300)	(291)	(298)	(301)	(301)	(289)
	P= .320	P= .006	P= .315	P= .000	P= .308	P= .084
SEXLUSER	.0474	.1309	.1018	.2495	-.0485	.2424
	(301)	(292)	(299)	(302)	(302)	(290)
	P= .413	P= .025	P= .079	P= .000	P= .401	P= .000
TSECUR	.0996	-.0003	-.0780	-.0381	.0947	-.0886
	(301)	(292)	(299)	(302)	(302)	(290)
	P= .085	P= .996	P= .178	P= .510	P= .100	P= .132
VEGCP1	.0908	.0552	-.6123	-.1640	-.2824	-.0577
	(301)	(292)	(299)	(302)	(302)	(290)
	P= .116	P= .347	P= .000	P= .004	P= .000	P= .328

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

	INCOME	MAIZEYD	P1GRAD	P1L_REG	P1SIZE	P1TDEED
CHILDED	.2422	.2886	.0399	.1852	.5050	.2697
	(291)	(289)	(300)	(297)	(300)	(292)
	P= .000	P= .000	P= .491	P= .001	P= .000	P= .000
CSEED1M	.3034	.3961	.1128	.2728	.2952	.3016
	(283)	(286)	(291)	(289)	(291)	(284)
	P= .000	P= .000	P= .055	P= .000	P= .000	P= .000
CULTD1	-.0009	-.0241	-.3478	-.1422	-.4114	-.0668
	(289)	(287)	(298)	(295)	(298)	(290)
	P= .988	P= .685	P= .000	P= .014	P= .000	P= .257
EDLUSER	.4068	.2576	-.1598	-.0278	.0955	.1013
	(292)	(290)	(301)	(298)	(301)	(293)
	P= .000	P= .000	P= .005	P= .632	P= .098	P= .083
ENVD1	-.0639	-.2290	.0916	.0390	-.0991	-.2010
	(292)	(290)	(301)	(298)	(301)	(293)
	P= .276	P= .000	P= .113	P= .503	P= .086	P= .001
FERT1M	.2642	.6504	.0700	.3322	.3096	.4366
	(281)	(284)	(289)	(287)	(289)	(282)
	P= .000	P= .000	P= .236	P= .000	P= .000	P= .000
INCOME	1.0000	.1874	-.0812	.0199	.2120	-.0848
	(292)	(281)	(291)	(288)	(291)	(284)
	P= .	P= .002	P= .167	P= .736	P= .000	P= .154
MAIZEYD	.1874	1.0000	.2034	.3461	.2348	.5329
	(281)	(290)	(289)	(286)	(290)	(281)
	P= .002	P= .	P= .001	P= .000	P= .000	P= .000
P1GRAD	-.0812	.2034	1.0000	.3332	.1720	.0834
	(291)	(289)	(301)	(298)	(300)	(293)
	P= .167	P= .001	P= .	P= .000	P= .003	P= .154
P1L_REG	.0199	.3461	.3332	1.0000	.2648	.4111
	(288)	(286)	(298)	(298)	(297)	(293)
	P= .736	P= .000	P= .000	P= .	P= .000	P= .000
P1SIZE	.2120	.2348	.1720	.2648	1.0000	.2899
	(291)	(290)	(300)	(297)	(301)	(292)
	P= .000	P= .000	P= .003	P= .000	P= .	P= .000
P1TDEED	-.0848	.5329	.0834	.4111	.2899	1.0000
	(284)	(281)	(293)	(293)	(292)	(293)
	P= .154	P= .000	P= .154	P= .000	P= .000	P= .
SEXHH	.1509	.0472	-.0327	-.0199	.0335	-.0543
	(291)	(289)	(300)	(297)	(300)	(292)
	P= .010	P= .424	P= .572	P= .732	P= .564	P= .355
SEXLUSER	.1123	.2430	.0257	.2273	.0342	.2011
	(292)	(290)	(301)	(298)	(301)	(293)
	P= .055	P= .000	P= .657	P= .000	P= .554	P= .001
TSECUR	.0669	-.0057	.1321	.1908	.0548	-.0196
	(292)	(290)	(301)	(298)	(301)	(293)
	P= .255	P= .923	P= .022	P= .001	P= .344	P= .738
VEGCP1	-.0501	-.0240	.2627	.0744	.3241	.0888
	(292)	(290)	(301)	(298)	(301)	(293)
	P= .394	P= .684	P= .000	P= .200	P= .000	P= .130

(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed

	SEXHH	SEXLUSER	TSECUR	VEGCP1
CHILDED	-.0577	.0474	.0996	.0908
	(300)	(301)	(301)	(301)
	P= .320	P= .413	P= .085	P= .116
CSEED1M	.1623	.1309	-.0003	.0552
	(291)	(292)	(292)	(292)
	P= .006	P= .025	P= .996	P= .347
CULTD1	-.0584	.1018	-.0780	-.6123
	(298)	(299)	(299)	(299)
	P= .315	P= .079	P= .178	P= .000
EDLUSER	.2403	.2495	-.0381	-.1640
	(301)	(302)	(302)	(302)
	P= .000	P= .000	P= .510	P= .004
ENVD1	-.0589	-.0485	.0947	-.2824
	(301)	(302)	(302)	(302)
	P= .308	P= .401	P= .100	P= .000
FERT1M	.1019	.2424	-.0886	-.0577
	(289)	(290)	(290)	(290)
	P= .084	P= .000	P= .132	P= .328
INCOME	.1509	.1123	.0669	-.0501
	(291)	(292)	(292)	(292)
	P= .010	P= .055	P= .255	P= .394
MAIZEYD	.0472	.2430	-.0057	-.0240
	(289)	(290)	(290)	(290)
	P= .424	P= .000	P= .923	P= .684
P1GRAD	-.0327	.0257	.1321	.2627
	(300)	(301)	(301)	(301)
	P= .572	P= .657	P= .022	P= .000
P1L_REG	-.0199	.2273	.1908	.0744
	(297)	(298)	(298)	(298)
	P= .732	P= .000	P= .001	P= .200
P1SIZE	.0335	.0342	.0548	.3241
	(300)	(301)	(301)	(301)
	P= .564	P= .554	P= .344	P= .000
P1TDEED	-.0543	.2011	-.0196	.0888
	(292)	(293)	(293)	(293)
	P= .355	P= .001	P= .738	P= .130
SEXHH	1.0000	.5287	.0504	.0669
	(301)	(301)	(301)	(301)
	P= .	P= .000	P= .384	P= .247
SEXLUSER	.5287	1.0000	.0799	-.0667
	(301)	(302)	(302)	(302)
	P= .000	P= .	P= .166	P= .248
TSECUR	.0504	.0799	1.0000	.0717
	(301)	(302)	(302)	(302)
	P= .384	P= .166	P= .	P= .214
VEGCP1	.0669	-.0667	.0717	1.0000
	(301)	(302)	(302)	(310)
	P= .247	P= .248	P= .214	P= .

(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed

Annex 2: Crosstabs and Pearson Chi-square Coefficients for Tenure Security and Investment in Land Improvement

	Tenure Security				Total
Ridge Building	No	Yes with notification and approval	Yes with notification only	Yes	
Yes	7	12	27	17	63 (20.3%)
No	36	61	27	113	237 (76.5%)
Pearson Ch-square of 282.472 - Significance level of 0%					
Agroforestry					
Yes	24	64	26	93	207 (66.8%)
No	19	10	28	37	94 (30.3%)
Pearson Ch-square of 300.882 - Significance level of 0%					
Drainage Development					
Yes	2	8	17	23	50 (16.1%)
No	41	64	37	107	249 (80.3%)
Pearson Ch-square of 296.305 - Significance level of 0%					
Terracing/Trenching					
Yes	11	24	22	51	108 (34.8%)
No	32	50	32	79	193 (62.3%)
Pearson Ch-square of 278.451 - Significance level of 0%					
Stump Removal					
Yes	11	59	30	78	178 (57.4%)
No	32	15	24	52	123 (39.7%)
Pearson Ch-square of 309.141 - Significance level of 0%					
Fencing					
Yes	24	43	39	74	180 (58.1%)
No	19	29	15	56	119 38.4%)
Pearson Ch-square of 285.492 - Significance level of 0%					

Part two – Agricultural Markets

CHAPTER FOUR

Market Liberalisation and Agriculture in Kenya

Stephen Njuguna Karingi and Hezron Omare Nyangito

Market Liberalisation and Agriculture in Kenya

Kenya's Economy Dependence on Agriculture

Kenya's agricultural sector is an important stimulus for economic growth, with a growth multiplier of 1.64 (Block and Timmer, 1994). For every 1 percent growth in agriculture, the overall economy grows by 1.64 percent. Agriculture is the mainstay of the country's economy, providing over 24% of GDP (measured in constant 1982 prices), 53% of merchandise export-earnings and direct employment for 62% of the labour force. The Sessional Paper No. 2 of 1994 on national food policy underscores the importance of agriculture in meeting national food supply needs for all Kenyans in all regions (Republic of Kenya, 1994). This requires food production to increase at a rate greater than the population growth rate, currently estimated at 2.1 percent[1], taking into account the fact that 56 percent of the population now lives below the poverty rate.
Dependency on the agriculture sector for export earnings and employment generation will continue for a while because more than 80 percent of the population engage in agriculture and live in rural areas. In fact, smallholder agriculture accounts for the largest share of new labour (Republic of Kenya, 1997). Additionally, 33 percent of manufacturing sector's output is based on agricultural inputs (Pearson et al. 1995). Thus, with its prominence in total output, employment and trade, the growth of the agriculture sector will be relied upon as a key stimulant for rapid economic growth, increase in income and job creation for Kenyans.

Recent Trends in Agricultural Sector Production

Agricultural sector's output growth rate slowed markedly in the 1960s and 1970s from nearly five percent per year to less than three percent (Pearson et al. 1995). Recent rates have been less than the rate of population growth (Table 1).

Table 1: Trends in Real Agricultural GDP Growth Rates in Kenya

Year	Real agricultural GDP growth rates
1971-1975	6.40
1976-1980	3.89
1981-1985	3.14
1986-1990	4.25
1991-1995	0.11
1996-1998	2.42
1998	1.5[2]
1999	1.2[2]

Source: Mbithi, 2000.

The 1970s average real agricultural GDP growth rates were four times higher than the 1990s'. The decline in the 1990s has serious implications for Kenya's economic

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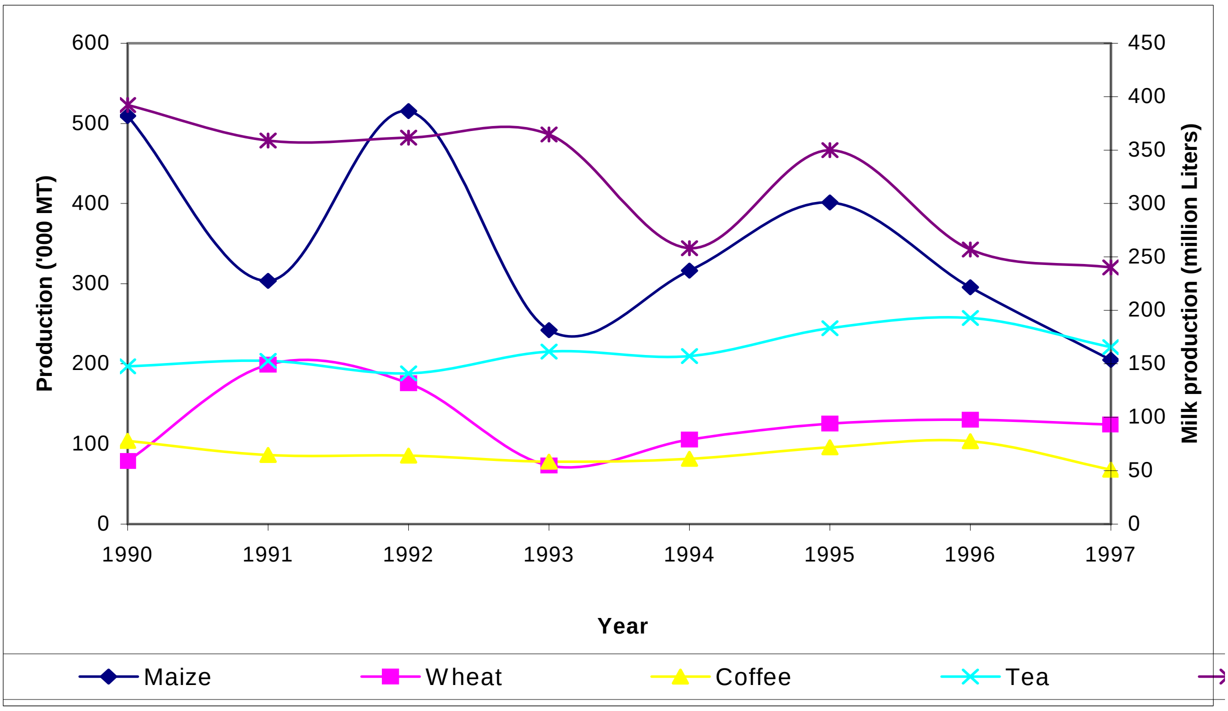
[1] Kenya's population census of 1999 showed dramatic decline in population growth rate, possibly due to population control measures and impacts of HIV/AIDS pandemic. The HIV/AIDS pandemic has serious implications for agricultural production with regard to its impact on labour productivity.

[2] Obtained from Republic of Kenya, 2000.

development, especially given the multiple roles of the agricultural sector. For example, food production per capita declined by around 15 percent during the 1980s, causing a severe reduction in domestic food availability.

Figure 1 shows trends in gross marketed production of some crops in the 1990s. Most sectors in agriculture have performed poorly in the last decade, a fact reflected in the overall poor real agricultural GDP growth. Tea generally has shown some stability while coffee has continued to decline. However, there have been some success stories in the horticultural sector, which has grown at about 20 percent in the last decade, which has maintained the positive real agriculture GDP growth.

Figure 1: Trends in Gross Marketed Production of Some Crops in Kenya



Source: Republic of Kenya (Statistical abstracts, various years)

Maize has the most year-to-year variation, and a trend suggesting that the quantity of marketed maize has been declining. Indeed, maize per capita production and yields have been declining (Mbithi, 2000; Thomas et al. 1997). These trends are blamed on the weather and changes in domestic policy towards market liberalization (Mbithi, 2000; Nyangito, 1999). Wheat shows less year-to-year fluctuation compared to maize while coffee and tea are more stable. Milk production shows a slight declining trend. A fundamental question then is whether economic policies such as trade liberalisation contributed to this performance, particularly the high variability of non-cash crop production.

Table 2 shows an interesting trend of the gross marketed production from the small farm sector in the 1990s, which has been increasing despite the general decline[2]. This suggests that the small farm sector is becoming more important in the share of total marketed production. However, gross marketed production from both large and small

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[2] Republic of Kenya (1996) defines small-scale farms as those farms between 0.2 and 12 hectares.

farms show annual fluctuations, with the fluctuations being higher in the small farm sector.

Table 2: Annual Percentage Change in Productions of Large and Small Farm Sector, and Share of Gross Marketed Production from Small Farms.

Year	Annual percent change in gross marketed share from large farms	Annual percent change in gross marketed share from small farms	Percentage share of small farms of total gross marketed production
1990	-2.12	24.73	55.37
1991	40.90	-12.21	44.72
1992	1.36	12.45	62.32
1993	56.10	68.11	64.16
1994	14.12	24.58	66.15
1995	8.04	19.67	68.40
1996	3.99	5.94	68.80
1997	6.68	11.90	69.82

Source: Republic of Kenya (statistical Abstracts, various years)

1. The Kenyan Trade Policy

After independence in 1964, Kenya became a contracting party of GATT. With the exception of Article VI on anti-dumping and countervailing duties, no provisions of the general agreement were incorporated into Kenyan laws. Many of Kenya's exports receive Generalized System of Preference (GSP) treatment from most developed countries. Like the other African, Caribbean and Pacific (ACP) countries, Kenya received preferences under the Lome' convention in the European Union markets and this will continue under the Cotonou Agreement of everything-but-arms signed in 2000 and valid until 2008.

Recent evolutions in Kenyan trade policy

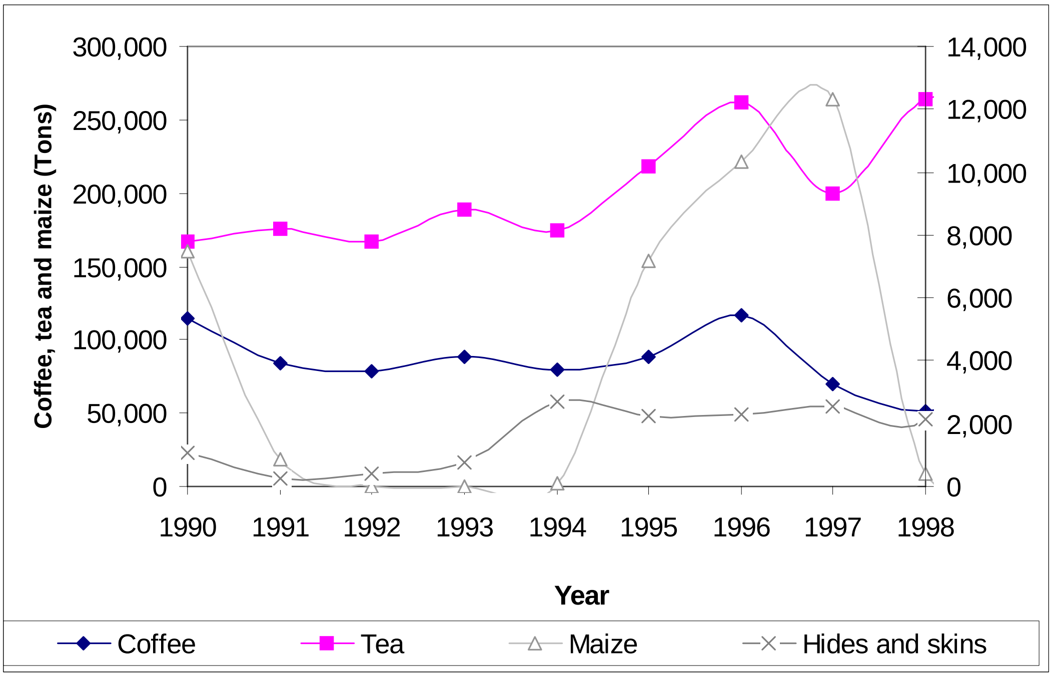
Before late 1980s, Kenya’s trade policies were mainly inward looking, encouraging import substitution and state revenue generation. The main instruments used included licensing, which was applied to all imports and to a large share of exports. There was excessive government control in most of economic sectors, foreign exchange was licensed, and import duties were applied. These policy strategies, while diversifying the manufacturing capacity, led to losses in the public sector and the economy, due to inefficient I government parastatals and induced structural rigidities.

Market liberalization efforts in the Kenyan economy began in late 1980s under the World Bank’s Structural Adjustment Programs (Swamy 1994). Since then, these trade policy reforms have been a core part of Kenya government's economic adjustment, as strongly implied in Sessional Paper No. 1 of 1986 (Republic of Kenya, 1986) – a document that lays out a forward-looking strategy for long-term economic growth. The major elements of the strategy included enhancing the role of agricultural markets and the private sector, incentives to encourage investment and exports, rationalization of the public sector expenditure and restructuring of parastatals, and reduction of regulation and controls on economic activity.

Consequently, trade liberalisation policies which included tariff reductions, removal of import licensing, lifting of import restrictions, relaxation of investment restrictions and dismantling of quantitative restrictions on imports were undertaken with the long-term objective of redressing economic imbalances, stimulating growth and restoring sustainable development. The policies were implemented to enable the economy cope with new international environment and withstand external shocks. The fact that domestic firms had to face competition from imports was the real focus of an export-led growth strategy compared to the previous import substitution strategy. The new focus implied the importance of maintenance of a competitive position by all producers within the economy. Moreover, the removal of quantitative restrictions on imports also meant that capital inputs could be accessed more easily and this, coupled with the exchange rate liberalization, would further stimulate the export-led economic growth.

However, the growth in the agriculture sector since the advent of trade liberalization is mixed (Nyangito and Okello 1998). Production of the main food commodities increase by 1984, peaked by 1987, but decline after 1991. This trend is attributed to output pricing and marketing problems, including increased food imports that depressed domestic food production. But trade liberalization has led to increased participation by the private sector in food trade and this might have enhanced agricultural production of particular crops (Republic of Kenya, 1994). On the cash crops sub sector, policy reforms have led to increased producer prices as a result of removal of explicit and implicit taxes but this has been accompanied by high costs of production as a result of removal of subsidies on inputs, leading to ambiguous overall impact results. Recent trends in export of principal crops show that there is a general fluctuation in quantities exported, with coffee and tea showing lower fluctuations as compared to maize, skins and hides (Figure 2). These observations indicate that the impacts of policy reforms, particularly trade liberalization on the performance of the agricultural sector are not clear.

Figure 2: Recent trends in domestic export of Kenya's principal commodities during liberalisation and immediate post-liberalisation period



This study set out to explore how trade liberalization contributed to the performance of the agricultural sector in 1980s and 1990s, when compared to the expectations from the policy reforms. This is important because the inability of the agricultural sector to maintain reasonable growth rates and the frightening scenario that Kenya faces if the failure persists puts in focus the fortunes expected from trade liberalizing policies. Hence, it is important to seek a better understanding of both the direct and indirect effects of trade policies on agriculture through an explicit consideration of the relationships between agriculture and the policies.

This study was based on the acknowledgement that economy-wide policies are as important as sector specific policies in affecting agricultural performance. Some of the studies, which have shown this relationship, include analysis of the economic impacts of tariffs in Australia (Siriwardana, 1996) and analysis of the impacts of external shocks in the Kenyan economy (Karingi, 1998).

The study strives to quantify the effects of trade liberalisation policies on the Kenyan agricultural economy and uses a computable general equilibrium (CGE) model for Kenya (discussed below). 1986 was picked as the base year[3], being the most recent year when social accounting matrices (SAM) database required to implement the CGE

[3] Ideally, it would have been good to have a more recent base year. Structural economic changes that occurred from a baseline of 1986 might not be uninformative in terms of policy analysis, but would give direction and magnitudes of impacts. But still, using 1986 as a starting point is not unrealistic even though we are looking at the issues of the 1990s since we recognise that policy changes for different agricultural commodities in Kenya were staggered out from the late 1980s.

model for Kenya are available.[4] Besides, 1986 is the year when the government of Kenya spelt out clearly its goal to adopt trade liberalization policies (Kenya, 1986). Using 1986 provides a good benchmark to analyze the impacts of these policies. The base year was used to simulate the expected outcomes of the trade policies on various macroeconomic variables, agricultural output, agricultural employment, rural incomes, agricultural prices and agricultural exports. These outcomes can be compared to the actual observed outcomes to identify the existing divergences.

3. Objectives

The objective of this study was to quantify economy-wide effects of trade liberalisation policies with particular reference to Kenya's agricultural sector performance. The empirical evidence resulting from the analysis may be used to inform the discussion of agriculture's role in poverty reducing strategies in a liberalised trade regime. The implications for the agricultural sector competitiveness in this regime and therefore its ability to contribute to reduction of poverty in the rural areas has specially been examined in the study.

Two objectives have been addressed in this study.

- First, a CGE model of the Kenyan economy has been used to determine the effects of reducing import tariffs for the agricultural and manufacturing sectors.
- Second, implications for agriculture's role in poverty reduction in the light of its performance under a liberalised trade environment are discussed.

4. Hypothesis and research questions

An implicit hypothesis of the study was that trade liberalisation has significant benefits to the economy and by extension the agricultural sector. The key questions for this study were: First, how has trade liberalization policies affected the performance of Kenyan economy particularly, with special reference to the role of the agricultural sector. Secondly, the study sought to find out how the performance of the agricultural sector influences poverty reduction through income, employment and foreign exchange earnings.

[4] Initially, this study had proposed to use 1991 as the base year. However, unlike the 1986 SAM, the 1991 SAM does not have a disaggregation of the consumption expenditure by households nor is the labour disaggregated to the various categories identified in the model. Due to lack of a disaggregated database, the idea of having simulations that take 1991, as an extra benchmark could not be pursued.

5. The Model

The interest of this study was to see how trade policy measures might impact on the agricultural sector. Such impacts of trade policies, which include tariff reductions, removal of import licensing, lifting of import restrictions, and dismantling of quantitative restrictions on imports, can be simulated using an economy-wide model for Kenya. The economy-wide model indicates the relationship that exists between inputs and outputs and linkages of sectors within an economy. The model to be used in the simulations is an economy-wide model in the form of a multi-agent and multi-commodity model, that is, a computable general equilibrium (CGE) model. The changes in output variables such as agricultural output or earnings from a chosen benchmark are estimated and this is considered as the impacts of the simulated trade policies.

A number of scenarios of trade policies using changes in the trade policy instruments, tariffs and quantitative restrictions, can be simulated to help identify the impacts on agricultural performance. The trade policy measures are likely to have had an impact on the agricultural sector in various other ways apart from changes in outputs or earnings mentioned above. The impacts include among other things: effects on the sector's growth and structural change; agricultural exports; agricultural employment; investment allocation in the sector; and income distribution among the different rural household groups. These impacts can then be analyzed to determine their effects on poverty alleviation. Our study focuses only on one of these trade reform instruments – import tariffs. The import tariffs formed the most significant trade barrier as they were historically set at very high levels.

It is difficult to analyse trade policy effects in a partial setting because there are substantial indirect effects on other sectors of the economy that have linkages with the agricultural sector. Therefore, a CGE model is the appropriate method of analysis for this study, with advantages of taking into account the general equilibrium effects. Also, the interaction of different policy variables, as implemented in Kenya, can be understood. In cases where the policies refer to the past, the model can be used for counterfactual simulation of policies other than those actually adopted to see whether a better performance would have resulted. The advantages of multi-commodity economy-wide models such as the CGE models notwithstanding, it is important to bring out some important caveats/weaknesses to applications of such models. A CGE model like the one described below does not capture variables like politics, weather, governance, donor support (confidence) etc. yet these factors have a great impact on the performance of the agricultural sector. However, one can argue that the model can capture donor support through the exogenous foreign inflows as a proxy. Moreover, probably politics can be captured through instruments such as taxation and expenditure as proxies which in reality depend on political ideology of a given Government.

The Kenyan economy CGE model assumes profit maximization behavior by producers, utility maximization by consumers, and markets which clear through flexible adjustment in wages and prices.[5] The structure of Kenyan Economy General Equilibrium Model (KEGEM) follows the standard neoclassical specification of the CGE model in Dervis *et al.* (1982), albeit with some modifications. The most important

[5] More details about this model including the algebraic derivations of the equations are described in Karingi (1998).

modification is the formulation of the production structure in the form used in ORANI (Dixon et al. 1977, Dixon et al. 1982) and MONASH-MRF (Peter et al. 1996) models of the Australian economy allowing the intermediate inputs to be differentiated by source.

Production technology

In order to accommodate various degrees of substitution and different elasticities among the different factors of production specified for Kenya, KEGEM proposes a nested production structure technology such as the one used in Dixon et al. (1977), Wong (1990) and Mitra (1994). The production technology exhibits constant returns to scale and is in three level forms as represented in Equation (1):

$$X_i = A_i^X \min[CES(ID_{ji}, IM_{ji}); CES(K_i, CES(L_{li}))] \tag{1}$$

where

A_i^X = Efficiency parameter capturing productivity of the primary and intermediate factors.

X_i = Supply of gross sectoral production in sector *i*.

ID_{ji} = Domestically produced intermediate commodity in sector *j* used as input in sector *i* to form the sector's composite intermediate commodity.

IM_{ji} = Imported intermediate commodity in sector *j* used as input in sector *i* to form the sector's composite intermediate commodity.

K_i = Demand for capital in sector *i*.

L_{li} = Demand for labour input of category *l* used in sector *i*.

At the top level, composite value added input and a composite intermediate input are used in fixed proportions to the output using a Leontief production function. The Leontief combination of the value-added input, VA_i, and composite intermediate input, N_{ji}, at the first level of gross sectoral production, X_i, is given in Equation (2):

$$X_i = A_i^X \min\left(\alpha_{N_{ji}} N_{ji}; \alpha_{VA_i} VA_i\right) \tag{2}$$

where A_i^X is the efficiency parameter capturing factor productivity for gross sectoral output. $\alpha_{N_{ji}}$ and α_{VA_i} are the distribution (weighting) parameters for the composite intermediate input and composite value-added factor respectively.

For the other two levels, a constant elasticity of substitution (CES) assumption is invoked. Substitution is allowed between imported and domestic intermediate inputs of the same type and among the primary factors. Domestically produced intermediate inputs are differentiated from imported intermediate inputs by a CES function that produces the composite intermediate input, N_{ji}, as shown in Equation (3):

$$N_{ji} = CES(ID_{ji,} IM_{ji}) = A_{ji}^N \left(\alpha_{ID_{ji}} ID_{ji}^{-\rho_{n_i}} + \alpha_{IM_{ji}} IM_{ji}^{-\rho_{n_i}}\right)^{-1/\rho_{n_i}} \tag{3}$$

Here, A_{ji}^N is the efficiency parameter for the formation of the composite intermediate input and ρ_{n_i} is the substitution parameter for the two intermediate inputs from different

sources for each sector. $\alpha_{IM_{ji}}$ and $\alpha_{ID_{ji}}$ are the distribution parameters[6] for intermediate inputs by source for a given sector *i*.
Equation (4) is the formation of effective value-added input. It describes the CES functions adopted to describe substitution possibilities between composite labour and capital in the creation of a unit of composite primary factor, the value-added factor, VA_i.

$$VA_i = CES(K_i, L_i) = A_i^{VA}\left(\alpha_{K_i} K_i^{-\rho_{va_i}} + \alpha_{L_i} L_i^{-\rho_{va_i}}\right)^{-1/\rho_{va_i}} \tag{4}$$

Here, A_i^{VA} is the efficiency parameter for the composite value-added input formation, ρ_{va_i} the substitution parameter of the inputs forming the composite value-added input. α_{K_i} and α_{L_i} are the distribution parameters for capital and labour in the formation of the composite value-added input respectively.

The two sets of relationships given by Equation (3) and Equation (4) describe how the top-level variables in the overall Leontief combination are determined. The third level applies only to the effective labour input required for value-added production. This effective labour is made from five types of labour categories (Equation (5)). The labour categories are unskilled, skilled, semi-professional, professional and self-employed labour. As in the second level, a CES function is specified. This allows for substitution between labour from different categories in the creation of a unit of composite labour, L_i:

$$L_i = CES(L_{li}) = A_i^L\left(\sum_l \alpha_{li} L_{li}^{-\rho_{L_i}}\right)^{-1/\rho_{L_i}} \tag{5}$$

The effective labour input is a CES aggregation of labour of different categories with *l* representing the labour category and A_i^L capturing the efficiency parameter for the formation of effective labour. α_{li} represents the distribution parameters of category *l* in the effective labour of sector *i*. ρ_{l_i} is the substitution parameter that determines the elasticity of substitution between different labour categories. The CES combination of the five types of labour assumes a single elasticity of substitution among all labour categories (that is, constancy of pair-wise substitution elasticities).

[6] If the functional form of the equation describing the formation of the composite intermediate input adopted a Cobb-Douglas production technology, the distribution parameters would represent cost shares of the intermediate inputs by source. However, due to the CES production technology used in KEGEM, then these weights are no longer simply cost shares but what Dixon et al. (1982, 1992) refer to as modified cost shares. Therefore, what is referred to here as distribution parameters for inputs forming the composite intermediate input are actually modified cost shares. The same case follows for distribution parameters of the inputs forming other composites within KEGEM where CES technology is invoked.

Factor demands

Like most neoclassical CGE models, KEGEM assumes producers are competitive and efficient. According to Dixon et al. (1977), the competitiveness is due to treatment of all input and output prices as exogenous. Efficiency, on the other hand, is implied by the fact that for any given level of output producers select the combination of inputs which minimizes their costs subject to maintaining a given output level. Given the separable and nested production structure, the profit-maximization or cost-minimization problem is separable. This means that if inputs are optimally chosen at every level of production technology, without reference to any other level, the overall input composition is efficient. Factor demands for composite intermediate and composite primary inputs are derived from Equation 2. The demands for intermediate inputs by source are derived through cost minimization subject to technological constraint of Equation 3. Similarly, the capital stock and composite labour demand are derived from Equation 4. Lastly, the demand for each labour category is derived through a cost minimization procedure subject to the constraint imposed by Equation 5.

Institutional Incomes

It is assumed, for simplicity, that there is one firm representing each sector. Profits are given by aggregate revenue minus all production costs, which include two intermediate inputs, wages, and capital costs of depreciation and interest payments. The firms are also faced with indirect taxes to government. Any subsidies received by firms are added to aggregate revenue when deriving the profits for each sector. Thus, profits represent returns to capital suppliers who are the firms' owners. The assumption inherent in this formulation is that KEGEM differentiates owners of capital from owners of labour. Firms then hire labour supplied by different households.

Households receive wage income by supplying labour to the firms, and this is the main source of their income. The net household transfers include payments to households by government and firm operators. Ideally, income transfers to households by firms are in the form of dividend payments, so that they are endogenous in the model. While this would remove the possibility of underestimating household incomes it does call for information on household equity holdings in different sectors, information that is not readily available in Kenya and any attempt to model transfers between domestic institutions where origin or destination of transfers is households would have to be arbitrary, involving guesswork. Thus, transfer payments were included as exogenous in the model closure while deriving household incomes. The government receives its income from taxation. The government receives direct taxes on the firms and households' income, indirect taxes on sectoral production and import duties.

Consumption demand by households

A linear expenditure system (LES), the Stone-Geary LES obtained from the constrained maximization of the Klein-Rubin utility function, was used for KEGEM. The LES employed has the property that theoretical restrictions of classical consumer demand theory are satisfied (Craven and Haidacher 1987). Unlike households, government in KEGEM does not seek to maximise utility but instead, it keeps the proportion of expenditure on each commodity fixed.

Savings

Households' savings are a fixed proportion of a given household income. Total savings for each household group depends on the savings rate and income for that group. Sectoral savings by firms are given by net after tax income and net sectoral transfers. Government savings are net government income net of government consumption of goods and services. Foreign savings are converted to domestic currency using the going exchange rate, and do supplement savings of domestic institutions to yield total savings.

Investment demand

The level of savings determines total investment. Investment demand by sector of origin is distributed to various sectors as is common to most CGE models and is borrowed from dynamic input-output models (Dervis et al. 1982).

Kenya's Trade with the Rest of the World

As in most CGE models, imperfect substitutability between domestic and imported commodities is assumed, enabling imported and local commodities to be considered as imperfect substitutes. By virtue of the CES assumptions, demand for the imported commodity is derived demand. Since Kenya does not control any large shares of any world export market, a small-country assumption is used. Therefore, export prices are fixed independent of quantities exported. In other words, Kenya faces an infinitely elastic export demand function. Products are assumed to be homogenous and there exists a downward-sloping demand curve for Kenya's exports, so that exports are determined through an export supply function alone without a formal incorporation of an export demand function. This is a framework that has been extensively applied in CGE models documented in Dervis et al. (1982).

Hence, to model export supply, one begins with recognition that a product can either be used locally or exported. In this model, Kenyan export supply functions are derived from an explicit optimizing framework that explains the proportions in which the domestic consumption and exports of the commodity appear in each sector's output. This framework entails assuming a constant elasticity of transformation between quantity sold locally and those exported as proposed in Powell and Gruen (1968). The optimization consists of a revenue-maximizing framework that has greater visibility of the theoretical underpinnings explained in Dixon et al. (1982).

The Price System in the Model

KEGEM uses several sets of prices, which are a combination of the framework in models such as ORANI (Dixon et al. 1982) and in Dervis et al. (1982). The domestic price of a commodity produced in sector i is determined as in ORANI. However, KEGEM differentiates the basic (domestic) price[7] with producer and consumer prices.

[7] The basic price of domestically produced commodity is the price received by producers. It excludes sales tax (or value added tax as the case may be), and transport and other margin costs in the transfer of the produced commodity from producers to users. In this case, basic prices are assumed to be the same across producing industries and across users.

The producer and consumer prices are determined as composites of the domestic (basic) price and the export price and import price respectively as in models that use the Dervis et al. (1982) style. The prices of effective inputs formed in the nested production structure are determined in a similar fashion to those in ORANI.

The key assumption in determining the basic price is that, in equilibrium, all firms make zero profit, achieved by setting the basic price equal to unit cost of production. As explained in Siriwardana (1996), the assumption of constant returns to scale in production and competitive pricing behavior in each of the economic activities ensures that zero pure profits are earned in equilibrium. The price of the domestic commodity is the sum of payments for intermediate inputs, labour services and capital payments, such that it is an average price of the costs of inputs. The implication of the basic price equation is that the basic value of good *i* is a weighted average of the prices of the inputs to the production of *i*, the weights being the cost shares of each input. Given the domestic price of a given sector's commodity, the purchasing price for the domestic intermediate input produced in sector *j* used in sector *i* can be deduced. In ORANI-style models, the basic value of a commodity is the price paid to producers. The producer price in KEGEM is a combination of the basic (domestic) price with the export price in domestic currency. The composite producer price is, therefore, a weighted average of the domestic commodity and export commodity price.

The aggregate world price for commodities is exogenous and fixed. For the period covered by this study, export taxes or subsidies were not an important policy instrument for the Kenyan government, hence, the export price equation differs with most CGE models in that it does not include the export subsidy (tax) variable. Quantities of a commodity sold locally are combined with quantities imported using a constant elasticity of substitution aggregation function to determine the total supply of the composite commodity. The domestic price is combined with the import price in domestic currency to determine the composite consumer price. It follows that the price of the composite commodity, is a weighted average of the import price and the local market price.

Import prices, are equal to world price of imports, converted into Kenyan shillings at prevailing exchange rate, and adjusted for import taxes. The purchasers' price for the imported intermediate commodity from sector *j* used as an input in sector *i* is given by a similar equation to that of imports, adjusted for indirect taxes. The introduction of exchange rate and exogenous world import prices in the imports price equation allows world prices to have a determining influence on Kenyan domestic prices.

Due to the nested and separable nature of KEGEM, there are other important prices whose origins need to be explained. These are the prices of the composites that are formed in the assumed production technology. They are the composite prices for the effective intermediate input, effective primary input and effective labour input. It is worth remembering that these composite commodities have been assumed to involve independent decisions, that is, the separability assumption. Therefore, it is plausible that for each of these composites there is an independent price equation. The price for these effective units are formed in a manner similar to the ORANI-style models in particular the MONASH-MRF model (see Peter et al. 1996). For instance, the price of the composite intermediate commodity *j* used in the production process of sector *i* is a cost-weighted Divisia index of individual prices of intermediate inputs by source.

The value-added price is defined through an equation that captures prices of primary inputs. The effective primary factor price is a cost-weighted Divisia index of the rental price of capital and the average sectoral wage. The rental price of capital is endogenous and changes accordingly to clear the market for the fixed capital and is different compared to the price of capital goods or the price of assets used for investment in a given sector. The wage mechanism adopted for the Kenyan labour markets affect the values of equilibrium quantities for output and endogenous prices. However, in order to uphold consistency with price formation for the other composites in the production structure, the sectoral wage is determined by a weighted average of wages of different labour categories.

That is, the average wage is a Divisia index of the wages of different labour categories. The wage rate of different occupations is derived through an indexation to the consumer price index. The consumer price index is computed through a weighting formula from the price of the composite domestic commodity, capturing both domestic and import prices. The consumer price index captures the differing influences that domestic and imported inputs in the different sectors have in the Kenyan economy. The producer price index is computed in KEGEM in a manner similar to the CPI. The producer price index captures both domestic and export prices.

Equilibrium in the Products and Factor Markets

To complete the model, equilibrium is imposed in product markets between demand and supply of domestic products. That is, the model ensures that demand equals supply for domestically produced commodities. The left-hand side of equilibrium equation in the product markets is the supply while the right hand side captures the total demand, which is made up of local demand of domestic output for intermediate inputs; demands for households' consumption; demands for government purchases; demand for inputs to capital formation; and export supply. Unlike in ORANI, the final demands in KEGEM are composites of local and imported products. Total demand is the sum of all demands by households, government and other sectors for intermediate and investment use. Therefore, there is a market-clearing equation, ensuring equilibrium in every composite commodity markets. The condition for balance of trade equilibrium is formulated as part of the market equilibrium conditions in domestic currency.

Tyler and Akinboade (1992) found that Keynesian closure could be applied to Kenya's labour market, which assumes unlimited supply of labour at a fixed nominal wage so that the level of employment is determined endogenously by demand for labour. In this study, this closure is applied in the simulation of import tariffs. Essentially, employers are assumed to obtain as much labour as they would like to employ at prevailing real wage rates. With a wage indexation parameter of one, then the real wages of the different occupations are unaffected by the tariff changes.[8] This assumption is realistic for Kenya given that historically there have been high rates of unemployment. Moreover, real wages in Kenya have mainly been determined by bargaining processes rather than by changes in the labour market conditions. Besides the assumption on labour, it is also assumed that capital is fixed and is sector specific.

[8] KEGEM is mix of linear and non-linear equations. Therefore, it is unlikely that there will be a perfect match between the change in the price index and the real wage given the outcome on nominal wage. A discrepancy in the change in the price index vis-à-vis the change in the real wage is acceptable and this is seen in the results discussed later in the paper.

The Macroeconomic closure

Since the number of variables exceeds the number of equations in KEGEM, it is necessary to have predetermined variables to solve the equations. This involves determining the closure of the model or determining the economic environment under which the simulations are made. In closing KEGEM, product and factor prices are endogenously determined and world prices of exports and imports are exogenous. There is no restriction on the balance of trade, which is also endogenous in the model. The different labour types are assumed to be available in unlimited supplies with wages for different labour categories indexed to the consumer price index with indexation ranging between zero and one. For example, when the wage indexation parameter is one an unlimited supply of labour is available at fixed real wages.

Total savings (from domestic and foreign sources) are distributed in fixed value shares to investment in the three production sectors. Investment is endogenously determined and adjusts to the level of savings. Foreign savings, unlike domestic savings, are exogenously determined. There are no direct connections between investment and capital stock and capital stock is exogenous and sector specific unlike for the labour categories where labour shifts between categories. In other words, sectoral investment is endogenous, and does not augment capital stocks. This means that all the results from the simulations using the model are short run. The exchange rate is also exogenous and acts as the numeraire, determining the absolute price level.

All the tax parameters for direct, indirect and import taxes are exogenous. The tax parameters are the fiscal and trade policy instruments available to government. Government total consumption of goods and services is also exogenously determined and is treated as a fiscal policy instrument. The level of subsidies in each of the producing sectors is also exogenously determined. This closure captures the assumptions underlying the simulations in KEGEM, whose full equations and variables are listed in the Appendix in Tables A.1 and A.2 while the coefficients used in the model are listed in Table A.3. Appendix Table A.4 shows the model closure conditions.

6. Analyzing Trade Liberalization in the late 1980s

In the 1980s, the SAPs were instituted by the World Bank and International Monetary Fund, which together with other bilateral donors made it hard for developing countries to obtain external credit without undertaking minimum economic and political reforms. One of the key conditionality was for the developing economies to shift from import substitution to market liberalization, which would improve the welfare of their populations by making it possible for more efficiently produced goods to be imported in these countries. In addition, the inefficiencies in resource allocation associated with the import substitution were seen to hinder rapid development in these economies. In addition to the SAPs, pressure for reforms was already coming from the General Agreements on Trade and Tariff, the predecessor of the World Trade Organization. Kenya published the *Sessional Paper No.1 on Economic Management for Renewed Growth*, discarding the import substitution model because, having experienced significant internal and external imbalances during the 1970s and the 1980s, the country felt it needed to open up its economy. One of the significant ways to achieve this was through trade liberalisation, particularly rationalization and reduction of import tariffs.

Specifically, the Government policies focused on deregulation and adoption of a market based incentive system to channel resources to productive uses as well as the liberalization of trade and marketing and removal of price controls to make the economy more competitive. Kenya had recognised the need to open up its economy and there has been arguments advanced to explain the stalling of the reforms. [9, 10]

KEGEM uses the 1986 Kenyan input-output and social accounting matrix tables to explore the implications of the trade liberalization process on the country's agricultural economy. There are three sectors identified in our analysis: agriculture, manufacturing and services. The original input-output tables and social accounting matrix have 37 production activities. Ten household groups (three urban and seven rural) are used and disaggregated on the basis of level of income for the urban and land ownership for rural households. Five labour categories are also identified.

Elasticity parameters used in KEGEM (Table 3 and Table 4) are assumed since no estimates existed for Kenya. Table 4 shows the income elasticities of the linear expenditure system. The Frisch parameter shows the relationship between price elasticities and expenditure elasticity in the context of an additive utility specification, which is assumed in the linear expenditure system.

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[9] Some authors have noted that the implementation of reforms since inception to late 1991 was not characterised by public controversy (Ikiara et al. 1993)

[10] A key argument for the policy inertia that developed towards the end of the 1980s was that Kenya's economic agenda could not resist political change that was encompassing Africa. The government concentrated its energy ensuring political survival rather than undertaking much needed economic reforms. Given the short-term costs of policy prescriptions made, political expediency overruled the significance of economic reforms.

Table 3: Sectoral Parameters

	Agriculture	Manufacturing	Service
Elasticity in intermediate input CES	0.80	0.60	0.40
Elasticity in value added CES	0.50	0.70	0.60
Elasticity in composite labour CES	0.50	0.50	0.50
Elasticity in import CES	0.80	0.60	0.40
Elasticity in export CET	1.30	0.80	0.30

Source: Average of equivalent values used in Fargeix and Sadoulet (1994) for Ecuador, Dervis et al. (1982) for a semi-industrialised Turkish economy, Dorosh (1996) for Madagascar and Dorosh et al. (1996) for Niger.

Table 4: Household Consumption Parameters (Income Elasticities)[11]

	Uhh1	Uhh2	Uhh3	Rhh1	Rhh2	Rhh3	Rhh4	Rhh5	Rhh6	Rhh7
Agriculture	0.90	0.70	0.50	0.90	0.80	0.70	0.60	0.50	0.50	0.70
Manufacturing	1.10	1.30	1.40	1.10	1.20	1.30	1.40	1.50	1.60	1.30
Service	0.70	0.80	1.10	0.70	0.80	0.90	1.00	1.10	1.20	0.80
Frisch parameter	-4.00	-3.00	-2.00	-4.50	-4.00	-3.50	-3.00	-2.50	-2.00	-3.50

Source: Fargeix and Sadoulet (1994) and Lluch et al. (1977).

The Trade Policy Simulation

The policy simulation in KEGEM is not a complete removal of all trade tariffs but a calculated reduction in the tariff rate. From the input-output and social accounting matrix data of 1986, the effective import duty rates were an average of 16.4 percent and 25.2 percent for agricultural and manufactured imports, respectively.[12,13] Table 5 shows the rates computed by averaging the tariff rates (import duty divided by import values).

[11] Uhh1 = Low income urban households; Uhh2 = Middle income urban households; Uhh3 = High income urban households; Rhh1 = Rural households holding less than 0.5 ha. and with little additional income; Rhh2 = Rural households holding 0.5 ha. with substantial additional income; Rhh3 = Rural households holding greater than 0.5 ha. but less than 1.0 ha. with little additional income; Rhh4 = Rural households (holding less than 0.5 ha. but less than 1.0 ha. with substantial additional income; Rhh5 = Rural households holding greater than 1.0 ha. but less than 8.0 ha.; Rhh6 = Rural households holding greater than 8.0 ha. (small farms only); Rhh7 = Other rural households.

[12] These import duty rates are calculated by the simple formula: tariff rate for sector i = total duty collections in sector i/total imports of sector i.

[13] These tariff rates are very similar to those calculated using National Accounts data as import duty divided by the import values.

Table 5: Calculated Tariff Rates (%) from Import Duty Collections in Selected Years

	1986	1989	1990	1992	1993	1994	1999
Food and Animals	15.0	17.0	5.0	2.0	4.0	6.2	32.6
Bev & Tobacco	92.0	84.0	73.0	24.0	22.0	18.8	13.9
Crude Materials	29.0	22.0	20.0	10.0	16.0	13.9	13.0
Mineral Fuels	11.0	8.0	7.0	0.23	8.0	20.7	15.1
Oils and Fats	2.6	6.4	0.6	15.5	24.1	22.1	9.0
Chemicals	14.4	16.5	17.8	10.2	10.9	12.8	5.4
Manufacturers	27.0	20.7	17.6	14.2	16.7	20.0	13.9
Equipment	17.0	12.0	12.7	8.7	16.6	18.1	11.3
Miscellaneous	17.0	14.8	13.7	8.4	12.7	11.4	11.4
Average Rate (Total Duty Collections)	16.5	13.8	12.5	7.6	12.7	16.0	12.8

Source: Statistical Abstracts, various issues

The effective tariff rates computed from the input-output tables and social accounting matrix tables for 1986 were close to those obtained from a similar computation using Kenya's national accounts information (Table 5).[14] We use the rates from the input-output tables and the social accounting matrix for 1986 as the starting point for this study as indicated earlier. In this simulation we investigate the implications of reducing the manufactured goods tariffs by 40 percent to an effective rate of 15 percent from the average of 25.2 percent and a reduction by a similar amount of the agricultural commodity tariffs to 10 percent from an effective rate of 16.4 percent.

Impacts on GDP Growth

The results of this simulation are shown in Table 6. At the macro level, trade liberalisation through lower import tariffs contributes half a percentage point improvement in the real GDP. As expected, output fell in the manufacturing sector by 1.6 percent due to import competition with the lower tariffs. Agricultural output, which was expected to benefit from cheaper inputs derived from trade liberalisation, improved marginally by 0.04 percent. Trade liberalisation in Kenya therefore results in expected outcome, that is, lower tariffs hurt the import-competing manufacturing sector while benefiting export-producing sectors such as agriculture. While there is no disaggregation of agricultural sector in the model, intuitively the losing sub-sectors are food crops (maize, wheat and rice) and the gainers are exports crop sector (tea, coffee and horticulture). As noted earlier, per capita food production declined in the post-liberalisation period while export crops, except for coffee, performed reasonably well over that period. The most likely explanation of these outcomes is that food crops sector faced stiffer competition from food imports from neighbouring countries but export crops benefit from cheaper inputs.

The result that the agricultural sector does still experience some positive growth may be then explained by the value added in the export crops sector being larger than the value added of the food crops. In spite of the postulation about the food sector and export

[14] The high increase of tariff levels for agricultural products is as a result of elimination of non-tariffs following Kenya's being a signatory to the WTO Agreement on Agriculture in 1995 and consequently adoption of tariffication as required by the Agreement

sector divide, it must be recognised that a sizable population of Kenyan small scale farmers grows food crops for home consumption, partly, due to market imperfections or failure. Cultivation of high value crops for export on the other hand for these small scale farmers could be constrained by factors such as high investment requirements, unfavourable climatic and soil conditions, lack of proper infrastructure in rural areas and poor extension services. These possible outcomes suggest safety nets and supportive measures for the vulnerable smallholder farmers during the liberalisation and immediate post-liberalisation periods.

Table 6: Macroeconomic, Trade Performance, and Employment Impacts of Trade Liberalisation

Macro Indicators	*Percentage Deviation from Base*
Real GDP	0.5
Consumer price index	-3.3
Balance of Trade (change)	1,633
Real government revenue	-11.2
Sectoral output (value added)	
Agriculture	0.04
Manufacturing	-1.6
Services	-0.6
Export supply	
Agriculture	0.9
Manufacturing	2.3
Services	0.1
Import demand	
Agriculture	3.5
Manufacturing	0.1
Services	-1.7
Investment demand	
Agriculture	-1.4
Manufacturing	-4.1
Services	-11.6
Sectoral employment demand	
Agriculture	0.4
Manufacturing	-5.2
Services	-1.0
Labour demand by category	
Unskilled	-2.2
Skilled	-2.9
Semi-professional	-1.8
Professional	-1.6
Self-employed	-1.0

Impacts on General Price

The lower tariffs are also associated with a decline in the general price level, with the CPI declining by 3.3 percent. The lower price regime contributes to the reduction of the cost of doing business in the economy and partially explains the positive real GDP growth and marginal improvement in the agricultural sector. While the low price regime is an appropriate macroeconomic outcome, the downside is that it serves as a disincentive to farmers. Inability to gain higher food prices may strengthen the argument that under trade liberalisation, food crops lost compared to export crops. Nyangito (1999) notes that, in deed, the food sub-sector was adversely affected by these policy reforms, especially as a result of poor prices induced by increased food imports.

Impacts on Current Account

The balance of trade improved under liberalization. This can be explained by the sectoral analysis of the exports and imports performance. Lower tariffs were accompanied by a higher import demand, especially in the agricultural sector, an increase that was more than compensated by the increase in manufactured exports. The manufactured exports growth reflected a possible shift between domestic consumption and exports.[15] While manufactured output declined due to tariff reduction, the increase in exports can be attributed to increased export supply at the expense of domestic demand. This is intuitive in that it is likely that the domestic demanded manufactured goods are not able to compete with imported substitutes leaving the manufacturers with the option of diversifying their products and their markets. Trade liberalisation acted as a catalyst for restructuring the domestic manufacturing sector, shifting into alternative products or higher value products and also diversifying product market. Evidence is given to support this argument by members of the Kenya Association of Manufacturers, explaining why Kenya's market share within the Common Market for Eastern and Southern Africa (COMESA) has improved in spite of difficult economic conditions since mid-1980s. The argument advanced is that faced with higher competition after liberalisation, Kenyan businesses, particularly the manufacturing businesses had to restructure and minimise production costs in order to sustain their businesses.

The results of these simulations counter arguments against trade liberalisation. Opponents of trade liberalisation, especially unilateral tariff reductions, argue that domestic manufactures would suffer from cheaper manufactured imports. However, the results show that for Kenya, reducing tariffs in the agricultural and manufacturing sectors does not necessarily imply adversity in domestic industries. Manufactured exports, contrary to expectations, rose by 2.3 percent in spite of the 1.6 percent decline in manufactured output. This is consistent with the fact that domestic production has high import content, to the extent that lower tariffs reduce production costs for domestic producers, raising their competitive position for some export products. The simulation results, therefore, show that reduced general price level in the domestic economy and lower costs of imported intermediate inputs produce a competitive position for the manufacturing sector that far exceeds the competition posed to the economy by imports in general. Another explanation to the outcome in manufactured exports could be the possibility of a shift in the product mix. That is, import substitution may have fallen while manufactured exports rose with trade liberalisation.

These results indicate that it is possible to capitalise on the positive impacts of trade liberalisation by undertaking rationalisation and restructuring process in the

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[15] As explained by an anonymous referee to an earlier version of this study, the result that domestic industries are able to allocate a larger share of their output to exports is possible in the real world. However, we would like to concur with the view of the anonymous referee that these results should be treated more as indicative given the prevailing uncertainties to the constant elasticity of transformation parameters, aspects of the model structure and the data.

manufactured goods sector. The focus seems to be given to the manufactured goods sub-sectors that are competitive. This would be best for the economy if they depend on inputs from the agricultural sector, as this would create opportunities for expanding agricultural production. In other words, it is important too and practical for Kenya to shift from food production to high value exports –horticulture and industrial crops- and also emphasize the importance of value adding in agricultural production through agro-processing.

Impact on Employment

There are mixed results on employment from a 40 percent reduction in the trade tariffs for both manufacturing and agriculture. The sectoral employment demand indicates that lower tariffs, except in agriculture, are associated with declining employment. As can be seen from Table 6, employment demand in agriculture rises marginally by about half a percent while for manufacturing and services, employment demand actually contracts. These results are intuitive in that employment in the import-competing manufacturing sector declines. One point that is important to note then is that the overall employment effects of tariff reduction could be positive or negative depending on which effect overcompensates the other. For instance, the increase in agricultural sector employment could more than compensate for the declines in the manufacturing sector employment[16].

There are also productivity implications of the sectoral employment effects discussed above. Improved competitiveness in domestic production, especially for manufactured goods, resulting in higher export supply is accompanied by higher productivity, an outcome pointing to a possible improvement in productivity in the manufacturing sector.[17] The implication of this result is that instead of the domestic manufacturing firms seeing liberalisation as a threat, they might pay more attention to the opportunities it presents especially if the other countries are liberalising. In order to realise the gains from these opportunities, restructuring takes place which is accompanied by job losses, hence the lower employment demand. But the remaining workforce appears to be more productive as the firms exploit the opportunities presented by the more liberalised trade. It is important however to note that with the higher productivity the displaced labour in manufacturing sector would need to be absorbed, say, in agricultural production to expand base for raw materials. The key concern would nevertheless be the lower wages in agriculture, which do not attract and retain labour.

It is therefore clear from this analysis that there are three important channels that reduced import tariffs could have to produce higher real GDP. The first one is that of

[16] Given the symmetry nature of the general equilibrium models results, the implication that emerges from this discussion is that if we were to instead raise tariffs by 40 percent rather than reduce them, then, it is possible for us to obtain a fall in total employment. Such a result implies that general increases in protection are an ineffective means of preserving aggregate domestic employment. Increased employment in the import-competing sector such as manufacturing (and this is one main argument for protection – about jobs) could easily be more than offset by declines in employment in other sectors such as agriculture given its import intensity in terms of inputs.

[17] The authors would also like to thank an anonymous referee who pointed out correctly that the combination of more output and less employment effects may also reflect a shift in less labour-intensive techniques within the limits of assumed constant elasticity of substitution functions and/or shift towards labour-intensive sectors to the extent that manufacturing has many sub-sectors.

competitiveness. The second one is that of productivity. The third one is a shift in the product mix, which entails a restructuring of the production systems so that there is a move away from import-competing goods as the latter are likely to become cheaper with liberalisation. These channels in Kenya are strongest in the manufacturing sector than in the agricultural sector. It can therefore be said from the analysis so far that whereas lower import tariffs tend to hurt import competing sectors such as manufacturing and have a positive impact on export producing sectors like agriculture, our results show that Kenya did not face a significantly bleak outcome from liberalising trade.

Employment Effects by Category

The distribution of the effects on employment among the different labour categories present an opportunity to analyse which group is affected most by trade liberalisation. This is important especially when policies need to be assessed in terms of their poverty reducing capacity and in this particular case income poverty. Our results indicate that unskilled and skilled workers are affected most by trade liberalisation as employment demand in these two categories fall by 2.2 and 2.9 percentage points respectively from the base. The reason for the reduced demand for services of skilled and unskilled workers is the restructuring necessitated on the manufacturing sector by trade liberalisation, as this is the sector where most of these workers are employed. The wage and income implications of these shifts are analyzed below.

An important issue that this study sought to address was the implication of trade liberalisation for poverty reduction efforts. This objective is addressed by analysing the impacts of lower tariffs on wage rates and by extension the labour incomes and household consumer demands. The deviations of the wage rates and labour incomes from the base as a result of trade liberalisation are shown in Table 6. The real incomes of the ten different household categories are also indicated. The results are reported both in nominal and real terms. In each case, the general price level deflates the nominal results in order to obtain the results in real terms. In nominal terms, the wage rate in the three sectors falls by one percent. This nominal decline is more than compensated by the fall in the general price level. Thus the trade liberalisation actually results in 2.4 percent rise in real wages in the economy.

The wage changes are more informative when looked from the point of view of the effects they have on labour incomes. The labour incomes are a function of the level of employment demand for the given labour category and the wage rate changes. From Table 7, trade liberalisation hurts most the skilled labour workers as the labour income for this category declines by 3.8 percent in nominal terms and 0.6 percentage points in real terms. The self-employed workers, the professionals and semi-professional workers are not affected adversely by trade liberalisation. Whereas labour incomes for these three groups also decline in nominal terms, these falls are more than compensated by the more favourable effects that trade liberalisation has on the general price level. Therefore, self-employed workers' real labour incomes rise by close to one and one-half percentage points above the base. The professional and semi-professional workers who are mainly outside the agricultural and manufacturing sectors also experience increased real labour incomes of 0.8 and 0.6 percentage points above the base respectively. The decline in the general price level contributes significantly to the improvement of real incomes for labour in spite of the fall in employment demand.

These results indicate that trade liberalisation has a positive impact on income poverty in real terms. This is well illustrated by the outcome in the household incomes. Table 7 shows the effects of trade liberalisation on the incomes of the three urban and seven rural household groups. On average, the losses in nominal terms are more for urban households when compared to the rural households. This is particularly the case for the low-income and middle-income urban households. These are the income group that contribute their labour services mainly to the unskilled and skilled labour categories that were seen to be affected most by the liberalisation and not surprisingly this is the result of the declining output in the manufacturing sector. The upper-income urban household's real incomes rose by 2.3 percentage points. This is the group that is comprised mainly of the professional and semi-professional workers.

Agricultural related activities in terms of their output only showed a marginal rise. On the aggregate however, labour demand also rose marginally. The rural household incomes, which are dependent on the performance in the agricultural sector, rose by at least 2 percents in real terms. While trade liberalisation results in falling labour demand in the economy, the impact on the agricultural sector is not that severe to the extent that the nominal falls in the rural incomes which are associated more to the developments in the nominal wage rate are more than compensated by the improvements in the general price level. Both the smallholder and large farmers benefit in real terms from the trade liberalisation. It is the large farmers however who benefit most as the real incomes for Rhh6 increased by 2.7 percentage points. The smaller farmers (Rhh1, Rhh2 and Rhh3) real incomes increase by an average 2.2 percentage points in real terms.

Our results therefore demonstrate that the macroeconomic impacts of a trade liberalisation policy are very critical to the ability of this policy to influence positively poverty reduction efforts. Where the policy results at the macroeconomic level in a more stable macroeconomic environment exemplified by a decline in the general level of prices, then the real wages, labour incomes and household incomes are more likely to be favourable and welfare improving in spite of such a policy's possible negative impact on output and employment of factor inputs such as labour. In the case of Kenya, it is evident from these results that trade liberalisation results in better real incomes for all income groups even though the performance of the agricultural and manufacturing sectors were poor in terms of output and in the case of manufacturing sector, there were employment declines.

Table 7: Wage Rates and Labour Incomes

Wage rate	*Nominal*	*Real*
Agriculture	-1.0	2.4
Manufacturing	-1.0	2.4
Services	-1.0	2.4
Labour incomes by category	*Nominal*	*Real*
Unskilled	-3.1	0.2
Skilled	-3.8	-0.6
Semi-professional	-2.8	0.6
Professional	-2.6	0.8
Self-employed	-2.0	1.4
Incomes for households	*Nominal*	*Real*
Uhh1	-2.8	0.5
Uhh2	-2.3	1.1
Uhh3	-1.1	2.3
Rhh1	-1.3	2.1
Rhh2	-1.2	2.2
Rhh3	-1.1	2.3
Rhh4	-1.2	2.2
Rhh5	-1.4	2.0
Rhh6	-0.8	2.7
Rhh7	-1.2	2.1

Overall welfare effects

Proponents of trade liberalisation argue that tariffs reduction lead to overall welfare improvement for a country's consumers since inefficient domestic producers are dislocated through their failure to compete with cheaper and higher quality imported goods. Improvements in consumer demand and diversification of products available is seen as an important indicator for poverty reduction. The trade liberalisation simulation undertaken in this study also provides some results of the implications of the policy to household demand. From the results discussed above, the real incomes of the households improved after the import tariffs for agricultural and manufactured goods were reduced. The results have also shown that there is a possibility of some substitution of domestic manufactures for imported manufactures since in spite of the manufactured output decline, the exports of the same also increased. Table 8 illustrates the implications of trade liberalisation for consumption demand in Kenya. The results are consistent with expectation since the demand for manufactured goods rise significantly both for the rural and urban households. The demand increase is more significant for rural households. These results indicate that with declining manufactured output, imported manufactures are able to be good substitutes. For instance the Rhh3 income group, demand for manufactured goods increases by 5.1 percentage points. An important observation worth noting is that rural households engaged in agricultural activities (Rhh1 – Rhh6) experience an increase in consumer demand for manufactured goods of 4.8 percentage points.

Demand for agricultural commodities by the urban households declines on average with trade liberalisation. Rural households on the other hand register improved demand for agricultural output. Like in the case of manufactured goods, rural households experience higher demand for agricultural commodities than urban households. The prominent outcome of these results is that trade liberalisation is not as beneficial to the urban households as is to the rural households. This can be explained by the fact that before trade liberalisation, the terms of trade are heavily in favor of urban households when compared to the rural households. Consequently, lower tariffs remove some of the advantages that the urban households may be having over the rural households.

Table 8: Consumer demand by household categories

	Agriculture	Manufacturing	Services
Uhh1	-0.8	3.0	-0.1
Uhh2	-0.8	3.0	-0.1
Uhh3	0.1	3.9	0.8
Rhh1	1.0	4.8	1.7
Rhh2	0.4	4.3	1.2
Rhh3	1.2	5.1	1.9
Rhh4	0.7	4.6	1.5
Rhh5	0.9	4.8	1.7
Rhh6	1.2	5.0	1.9
Rhh7	0.3	4.1	1.0

The results regarding consumer demand by household categories are consistent with the argument by proponents of globalisation (trade liberalisation is just a subset) that the welfare of the consumers improves when tariffs are reduced. As mentioned above, the higher welfare is in the form of rising real incomes as the cost of a typical basket of goods declines in a liberalised economy, which is also accompanied by a wider, and higher quality choices.

7. Conclusions and policy recommendations

This study uses a CGE framework to quantify economy-wide effects of trade liberalization in Kenya's economy, with special focus on the agricultural sector. The main thrust of policy change was the shift from protectionism to embrace openness, through substantial reduction of import tariffs. This did affect the performance of the agricultural sector either directly or indirectly. The study examines how the policy changes contributed to the performance of the agricultural sector in 1980s and 1990s and then compare this performance with the expectations from the policy reforms. A CGE model is appropriate given the many direct and indirect linkages that the agricultural sector has with other economic sectors. The study also explores the implications for agriculture's role in poverty reduction in light of the liberalized environment. This is done by testing two main hypotheses: first, how trade liberalization has affected the Kenya economy in general and specifically agriculture, and second how the performance of the agricultural sector impacts on poverty through income, employment and foreign exchange earnings. For instance, it uses tariff rates from the input-output tables and the social accounting matrix of 1986 to simulate the implications of reducing the manufactured goods tariff by 40% to an effective rate of 15% from the average of 25.2%.

Similar simulation is undertaken in the agricultural sector assuming a reduction to 10% from an effective rate of 16.4%. Lower tariffs hurt the import competing manufacturing sector while positively impacting on export producing sectors. In the agricultural sector, liberalization is thought to hurt food crops (maize, wheat and rice) due to competing imports from neighbouring countries while benefiting the exports crops sector (tea, coffee, horticulture). Another important outcome is that lowering tariffs leads to a fall in general price level with the CPI declining by 3.3%. The fall in general prices lowers the cost of doing business and therefore partly explains the positive real growth in GDP. However, low prices are a disincentive to farmers and perhaps this is why the food crops sub-sector is thought to perform poorly under liberalization unlike in the export sub-sector.

The impact of trade liberalization led to an improvement in the current account because the effects of high import demands rising from lower import tariffs were more than offset by increasing exports, especially manufactured exports. Overall, results of the impact of trade liberalization seem to contradict the argument that lowering tariffs competes out domestic manufacturers through importation of cheaper competing manufactures. The Kenya results do not support this argument. Contrary to expectations, trade liberalization led to a 2.3% increase in manufactured exports in spite of the 1.6% fall in manufactured output. Liberalization benefited exporters because low import tariffs lowered the cost of production inputs. The manufacturing process in Kenya has high import content and, therefore, cheaper imports served to raise the competitiveness of the exporting sector. Thus, the beneficial effects of a reduction in the general price level and cheaper imports more than offset the negative effects of competing imports.

Results of the impacts of lower tariffs on sectoral employment show a fall in employment except in agriculture. Thus, the increase in higher exports must be attributed to an increase in productivity since lower tariffs lead to a decline in employment in the sector. Based on these results, it could therefore be argued that trade liberalization is a better policy than no trade liberalization.

Finally, while the results from the analysis are not dramatic as the debate on trade liberalisation tend to be, there are still important results that have been highlighted. A unilateral 40% reduction in tariffs faced by the agricultural and manufacturing sectors results in marginal gains in the output of agriculture while the manufacturing sector declines. This result is intuitive and confirms the argument that for Kenya, the value added in the agricultural exports sector benefits from trade liberalisation as it faces lower production costs.

Results of this study show that trade liberalization is a good policy for achieving a general improvement in welfare, despite having a negative effect on output in agriculture and manufacturing. Trade liberalization improved real incomes and consumption demand for households. Since the beneficial effects of trade liberalization outweigh the negative effects, Kenya should rationalize and restructure the production of competitive manufactured goods in order to maximize these positive impacts. The positive gains could further trickle to the agricultural sector if it served as a source of inputs for the manufacturing sector. Thus, Kenya stands to gain more by shifting from food production to high value exports, mainly horticulture and industrial crops. Another strategy is to focus on value adding in agriculture through agro-processing as well as strategies to raise wages in agriculture in order to absorb and retain workers displaced from other sectors (manufacturing and services).

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Table A.1: Equation System for Real KEGEM

Identifier		Subscript Range	No.	Description
	Inputs demand			
(A.1)	$L_{li} = \left(\frac{L_i}{A_i^L}\right)\left(\sum_{l=1}^{5}\alpha_{li}^{1/(1+\rho_{L_i})} w_{li}^{\rho_{L_i}/(1+\rho_{L_i})}\right)^{1/\rho_{L_i}} \alpha_{li}^{1/(1+\rho_{L_i})} w_{li}^{-1/(1+\rho_{L_i})}$	i=1,...3; l=1,...5	15	Demand for labour categories
(A.2)	$K_i = \left(\frac{VA_i}{A_i^{VA}}\right)\left[\alpha_{K_i}^{1/(1+\rho_{va_i})} P_{k_i}^{\rho_{va_i}/(1+\rho_{va_i})} + \alpha_{L_i}^{1/(1+\rho_{va_i})} w_i^{\rho_{va_i}/(1+\rho_{va_i})}\right]^{1/\rho_{va_i}} \alpha_{K_i}^{1/(1+\rho_{va_i})} P_{k_i}^{-1/(1+\rho_{va_i})}$	i=1,...,3	3	Demand for capital
(A.3)	$L_i = \left(\frac{VA_i}{A_i^{VA}}\right)\left[\alpha_{K_i}^{1/(1+\rho_{va_i})} P_{k_i}^{\rho_{va_i}/(1+\rho_{va_i})} + \alpha_{L_i}^{1/(1+\rho_{va_i})} w_i^{\rho_{va_i}/(1+\rho_{va_i})}\right]^{1/\rho_{va_i}} \alpha_{L_i}^{1/(1+\rho_{va_i})} w_i^{-1/(1+\rho_{va_i})}$	i=1,...,3	3	Demand for composite labour
(A.4)	$ID_{ji} = \left(\frac{N_{ji}}{A_{ji}^N}\right)\left[P_{im_{ji}}^{\rho_{n_i}/(1+\rho_{n_i})} \alpha_{IM_{ji}}^{1/(1+\rho_{n_i})} + P_{id_{ji}}^{\rho_{n_i}/(1+\rho_{n_i})} \alpha_{ID_{ji}}^{1/(1+\rho_{n_i})}\right]^{1/\rho_{n_i}} \alpha_{ID_{ji}}^{1/(1+\rho_{n_i})} P_{id_{ji}}^{-1/(1+\rho_{n_i})}$	i=1,...,3; j=1,...,3	9	Domestic intermediate demand
(A.5)	$IM_{ji} = \left(\frac{N_{ji}}{A_{ji}^N}\right)\left[P_{im_{ji}}^{\rho_{n_i}/(1+\rho_{n_i})} \alpha_{IM_{ji}}^{1/(1+\rho_{n_i})} + P_{id_{ji}}^{\rho_{n_i}/(1+\rho_{n_i})} \alpha_{ID_{ji}}^{1/(1+\rho_{n_i})}\right]^{1/\rho_{n_i}} \alpha_{IM_{ji}}^{1/(1+\rho_{n_i})} P_{im_{ji}}^{-1/(1+\rho_{n_i})}$	i=1,...,3; j=1,...,3	9	Imported intermediate demand
(A.6)	$N_{ji} = \alpha_{N_{ji}}\left(\frac{X_i}{A_i^X}\right)$	i = 1,...,3; j=1,...,3	9	Composite intermediate demand
(A.7)	$VA_i = \alpha_{VA_i}\left(\frac{X_i}{A_i^X}\right)$	i=1,...,3	3	Composite value-added demand
	Institutions income			
(A.8)	$Y_i = P_{x_i} X_i - \sum_j P_{im_{ji}} IM_{ji} - \sum_j P_{id_{ji}} ID_{ji} - \sum_l w_{li} L_{li} - DEP_i - INT_i - ITAX_i + SUBS_i + NTF_i$	i=1,...3	3	Sectoral profits
(A.9)	$DEP_i = DEPR_i P_{a_i} K_i$	i=1,...,3	3	Consumption of fixed capital

(A.10) $P_{a_i} = \sum_j \varpi_{ji} P_{q_j}$	i=1,...,3; j = 1,...3	3	Capital assets price

Table A.1 (*continued*)

Identifier	Subscript Range	No.	Description
(A.11) $INT_i = r_i P_{k_i} K_i$	i=1,...,3	3	Interest payments by sector
(A.12) $ITAX_i = td_i P_{x_i} X_i$	i=1,...,3	3	Sectoral indirect taxes
(A.13) $Y_h = \sum_l \sum_i \beta_{hl} w_{li} L_{li} + NTH_h$	h=1,...,10	10	Households income by category
(A.14) $YG = \sum_h HTAX_h + \sum_i CTAX_i + \sum_i ITAX_i + \sum_i DUTY_i - \sum_i SUBS_i + NTG$		1	Government's income
(A.15) $HTAX_h = t_h Y_h$	h=1,...,10	10	Households direct taxes
(A.16) $CTAX_i = t_i Y_i$	i=1,...,3	3	Sectoral direct taxes
(A.17) $DUTY_i = tm_i P_{m_i} M_i$	i=1,...,3	3	Import duty
Product demand for consumption			
(A.18) $C_{ih} = \theta_{ih} + \dfrac{\beta_{ih}\left(Y_h - HTAX_h - SV_h - \sum_i P_{q_i}\theta_{ih}\right)}{P_{q_i}}$	h=1,...,10; i = 1,...,3	30	Household consumption
(A.19) $C_{ig} = \beta_i TGC$	i=1,...,3	3	Government consumption
Institutional savings and investment demand			
(A.20) $SV_h = s_h Y_h$	h=1,...,10	10	Households savings by category
(A.21) $SV_i = Y_i - CTAX_i - NTF_i$	i=1,...,3	3	Sectoral savings

(A.22) $SVG = YG - TGC$		1	Government savings
(A.23) $TSAV = \sum_h SV_h + \sum_i SV_i + SVG + SVR \cdot ER$		1	Total savings
(A.24) $I_i = \kappa_i TSAV$	i=1,...,3	3	Investment by destination sector
(A.25) $Z_j = \sum_i \varpi_{ji} I_i$	j=1,...3	3	Investment by sector of origin

Table A.1 (*continued*)

Identifier	Subscript Range	No.	Description
Kenya's trade with the rest of the world			
(A.26) $M_i = \left(\frac{P_{d_i}(1+td_i)}{P_{m_i}} \right)^{\sigma_{Q_i}} \left(\frac{\alpha_{D_i}}{\alpha_{M_i}} \right)^{\sigma_{Q_i}} D_i$	i=1,...,3	3	Import demand
(A.27) $E_i = \left(\frac{\gamma_{d_i}}{\gamma_{ei}} \right)^{\psi_{X_i}} \left(\frac{P_{e_i}}{P_{d_i}(1+td_i)} \right)^{\psi_{X_i}} D_i$	i=1,...,3	3	Export supply
Price system			
(A.28) $P_{d_i} X_i = \sum_l w_{li} L_{li} + \sum_j P_{im_{ji}} IM_{ji} + \sum_j P_{id_{ji}} ID_{ji} + P_{k_i} K_i$	i=1,...3	3	Zero profit for production
(A.29) $P_{id_{ji}} = P_{d_j}(1+td_j)$	i=1,...,3; j=1,...3	9	Purchasers price for dom. inter.
(A.30) $P_{x_i} X_i = P_{d_i}(1+td_i) D_i + P_{e_i} E_i$	i=1,...,3	3	Composite producer price
(A.31) $P_{e_i} = \overline{P}^{w}_{e_i} ER$	i=1,...,3	3	Export price

(A.32) $P_{q_i} Q_i = P_{d_i}(1+td_i)D_i + P_{m_i} M_i$	i=1,...,3	3	Composite consumer price
(A.33) $P_{m_i} = \overline{P}^w_{m_i}(1+tm_i)ER$	i=1,...,3	3	Import price
(A.34) $P_{im_{ji}} = \overline{P}^w_{m_i}(1+tm_i+td_i)ER$	i=1,...,3; j=1,...3	9	Purchasers price for imp. inter.
(A.35) $PN_{ji} N_{ji} = P_{im_{ji}} IM_{ji} + P_{id_{ji}} ID_{ji}$	i=1,...3; j=1,...3	9	Composite intermediate price
(A.36) $PVA_i VA_i = P_{k_i} K_i + w_i L_i$	i=1,...,3	3	Composite value added price
(A.37) $w_i L_i = \sum_l w_{li} L_{li}$	i=1,...,3	3	Composite sectoral wage
(A.38) $w_{li} = \varphi_l (P_\pi)^v$	i=1,...,3; l=1,...5	15	Wage indexation
(A.39) $P_\pi = \sum_i \mu_i P_{q_i}$		1	Consumer price index
(A.40) $P_\theta = \sum_i \mu_i P_{x_i}$		1	Producer price index

Table A.1 (*continued*)

Identifier	Subscript Range	No.	Description
Market clearing conditions			
(A.41) $X_j = DUR_j\left(\sum_h C_{jh} + CG_j + Z_j\right) + \sum_i ID_{ji} + E_j$	j=1,...,3	3	Equilibrium for domestic output
(A.42) $DUR_j = \dfrac{D_j}{M_j + D_j}$	j=1,...,3	3	Domestic use ratio
(A.43) $D_j = DUR_j\left(\sum_h C_{jh} + CG_j + Z_j\right) + \sum_i ID_{ji}$	j=1,...,3	3	Domestic absorption of prodn.

(A.44) $Q_j = \sum_i N_{ji} + \sum_h C_{jh} + CG_j + Z_j$	j=1,...,3	3	Dem. for composite commodity
(A.45) $BOT = \sum_i P_{e_i} E_i - \sum_i P_{m_i} M_i$		1	Trade balance in dom. currency
(A.46) $\sum_i L_{li} = L_l$	l=1,...5	5	Labour demand = labour supply
(A.47) $K_i = \overline{K_i}$	i=1,...,3	3	Capital demand = capital stock
Total			239

Table A.2: Variables of KEGEM

Variable	Subscript range	No.	Description
X_i	i=1,...,3	3	Gross outputs
N_{ji}	i=1,...,3; j=1,...,3	9	Composite intermediate commodity
VA_i	i=1,...,3	3	Value-added composites
L_i	i=1,...,3	3	Composite labour
ID_{ji}	i=1,...,3; j =1,...,3	9	Domestic intermediate input
IM_{ji}	i=1,...,3; j =1,...,3	9	Imported intermediate input
K_i	i=1,...,3	3	Demand for capital
L_{li}	l=1,...,5; i =1,...,3	15	Labour of category l
L_l	l=1,...,5	5	Supply of labour by category l
Y_i	i=1,...,3	3	Sectoral net income
Y_h	h=1,...,10	10	Income of household
YG		1	Government's total income
C_{jh}	j=1,...,3; h=1,...,10	30	Households of group h consumption demand
CG_j	j=1,...,3	3	Government's demand
Q_i	i=1,...,3	3	Composite commodity for use in the dom. economy sector
M_i	i=1,...,3	3	Imports
E_i	i=1,...,3	3	Exports supply
P_{d_i}	i=1,...,3	3	Price of domestic commodity
P_{m_i}	i=1,...,3	3	Import price in Kenyan shillings
P_{q_i}	i=1,...,3	3	Price of composite domestic commodity
PN_{ji}	i=1,...,3; j = 1,...,3	9	Price of composite intermediate input
$P_{id_{ji}}$	i=1,...,3; j = 1,...,3	9	Price of intermediate domestic input
$P_{im_{ji}}$	i=1,...,3; j = 1,...,3	9	Price of intermediate imported input
PVA_i	i=1,...,3	3	Price of composite value added
P_{k_i}	i=1,...,3	3	Rental price of capital
P_{a_i}	i=1,...,3	3	Price of assets
w_i	i =1,...,3	3	Wage rate
w_{li}	l=1,...,5; i = 1,...,3	15	Wage rate of labour category l
P_{e_i}	i=1,...,3	3	Export price in Kenyan shillings
P_{x_i}	i=1,...,3	3	Producer price
P_π		1	Consumer price index.
P_θ		1	Producer price index.
SV_h	h=1,...,10	10	Savings by households
SV_i	i=1,...,3	3	Savings by firms
SVG		1	Government savings.
$TSAV$		1	Total savings
I_i	i=1,...,3	3	Investment demand by sector of destination.
Z_i	i=1,...,3	3	Investment demand by sector of origin.

Table A.2 (*continued)*

Variable	Subscript range	No.	Description
D_i	i=1,...,3	3	Domestic commodity
DUR_j	j=1,...,3	3	Domestic use ratio
BOT		1	Balance of trade.
$CTAX_i$	i=1,...,3	3	Direct taxes
DEP_i	i=1,...,3	3	Depreciation
INT_i	i=1,...,3	3	Interest payments
$ITAX_i$	i=1,...,3	3	Indirect taxes from sector *i* excluding import tariffs.
$DUTY_i$	i=1,...,3	3	Import duties
$HTAX_h$	h=1,...,10	10	Direct taxes from households
ER		1	The exchange rate for the Kenyan shilling to the US dollar.
$\overline{P}_{m_i}^{w}$	i=1,...,3	3	World import prices
$\overline{P}_{e_i}^{w}$	i=1,...,3	3	World export prices
TGC		1	Government's total consumption
SVR		1	Foreign capital inflow
t_i	i=1,...,3	3	Tax rate on profits
t_h	h=1,...,10	10	Direct average tax rate for households
td_i	i=1,...,3	3	Indirect tax rate for commodities
tm_i	i=1,...,3	3	Import duty
$\overline{K}_i$	i=1,...,3	3	Fixed amount of sector specific capital stock.
r_i	i=1,...,3	3	Rate of interest
$DEPR_i$	i=1,...,3	3	Rate of depreciation
NTF_i	i=1,...,3	3	Net transfers
$SUBS_i$	i=1,...,3	3	Subsidy payments
NTH_h	h=1,...,10	10	Net transfers to household
NTG		1	Net transfers to government.
φ_l	l=1,...,5	5	Wage shifter by category
Total Variables		298	

Table A.3: Coefficients of KEGEM

Coefficient	Description
A_i^X	Efficiency parameter in gross sectoral production.
A_{ji}^N	Efficiency parameter in composite intermediate input.

A_i^{VA}	Efficiency parameter in value-added composite
A_i^L	Efficiency parameter in composite labour
α_{VA_i}	Distribution parameter for the composite value-added
$\alpha_{N_{ji}}$	Distribution parameter for composite intermediate
$\alpha_{ID_{ji}}$	Distribution parameter for intermediate domestic input
$\alpha_{IM_{ji}}$	Distribution parameter for the intermediate imported input
α_{K_i}	Distribution parameter for capital
α_{L_i}	Distribution parameter for composite labour
α_{li}	Distribution parameter for labour of category *l* in composite labour.
β_{ih}	Marginal budget share in household consumption.
θ_{ih}	The fixed level subsistence consumption by households
α_{D_i}	Distribution parameter for domestic commodity in the formation of the composite domestic commodity
α_{M_i}	Distribution parameter for imported commodity in the formation of the composite domestic commodity
γ_{d_i}	Distribution parameter for the domestic commodity in the CET function of gross production.
γ_{e_i}	Distribution parameter for the exported commodity in the CET function of gross production.
ρ_{x_i}	Substitution parameter of the composite value added input and composite intermediate input in the gross sectoral production
ρ_{n_i}	Substitution parameter between domestic and imported intermediate inputs.
ρ_{va_i}	Substitution parameter of the primary factors in the value-added composite formation
ρ_{L_i}	Substitution parameter of the different labour categories in the formation of composite labour
ϕ_{x_i}	Substitution parameter between domestic and export commodities in the transformation of gross product
σ_{Q_i}	Elasticity of substitution between domestic and imported goods
ν	Wage indexation parameter.
ψ_{X_i}	Elasticity of transformation between the domestically consumed and the exported components of gross sectoral product
μ_i	Weights of different sectors in aggregate price index .
β_{hl}	The proportion of household group *h* ownership of labour of category *l*
ϖ_{ij}	The share of commodity *j* in the capital good
β_i	Proportion of commodity in government's total consumption.
κ_i	Exogenous sectoral investment share in total investments.
s_h	Savings rate of a given household group *h*.

Table A.4: List of Exogenous Variables in KEGEM Closure

Variable	Subscript range	No.	Description
ER		1	The exchange rate for the Kenyan shilling to the US dollar.
$\overline{P}_{m_i}^{w}$	i=1,...,3	3	World import prices
$\overline{P}_{e_i}^{w}$	i=1,...,3	3	World export prices

TGC		1	Government's total consumption demand.
SVR		1	Foreign capital inflow
t_i	i=1,...,3	3	Tax rate on profits
t_h	h=1,...,10	10	Direct average tax rate for households
td_i	i=1,...,3	3	Indirect tax rate for commodities
tm_i	i=1,...,3	3	Import duty
$\overline{K}_i$	i=1,...,3	3	Fixed amount of sector specific capital stock.
r_i	i=1,...,3	3	Rate of interest
$DEPR_i$	i=1,...,3	3	Rate of depreciation
NTF_i	i=1,...,3	3	Net transfers
$SUBS_i$	i=1,...,3	3	Subsidy payments
NTH_h	h=1,...,10	10	Net transfers to household
NTG		1	Net transfers to government.
φ_l	l=1,...,5	5	Wage shifter by category l.
Total Variables		59	

CHAPTER FIVE

Post-Liberalization Maize Marketing in Kenya

Joseph T. Karugia, Stephen K. Wambugu and Willis Oluoch-Kosura

Post-Liberalization Maize Marketing in Kenya

1.0 INTRODUCTION AND PROBLEM STATEMENT

1.1 Background

Food security, the “access by all people at all times to enough food for an active, healthy life” (Ellis 1992), remains a major concern for the Kenyan government. The government’s sessional papers and other policy documents clearly emphasize this point (Kenya 1981, 1984, 1989, 1994c). In Kenya, as in other countries in Eastern and Southern Africa, the problem of food insecurity has become a major emotional and political preoccupation. Governments in the region aim for broad self-sufficiency in the production of major staple foodstuffs as a way of achieving food security. In Kenya food self-sufficiency is inextricably linked to maize, the main staple. Discussions of food shortages invariably center on maize shortages. As in other countries that depend on a single staple for sustaining food security, the availability of maize in Kenya takes on sociopolitical dimensions that transcend mere economic considerations. Such is the importance of maize that it has occupied a central place in Kenya’s agricultural policies, which have themselves undergone considerable evolution since independence.

The agricultural policies pursued in Kenya since independence can be roughly divided into two periods: the government control era from independence to the early 1980s and the policy reform period beginning in the early 1980s. During the former period, government participation dominated agricultural production, marketing, and investment activities. More recently, policies have gradually reduced government participation in the agricultural sector, especially in the marketing of agricultural products. The reform period can be further divided into two distinct phases according to the level of commitment and zeal with which these policy reforms were pursued: 1982 to 1992, and 1993 to date. The economic environment for agricultural development changed profoundly during these two phases.

The first attempts to introduce policy reforms in the agricultural sector in Kenya appeared in the Fourth Development Plan of 1979-1983 (Kenya 1979). These reforms focused on gradually decreasing price controls and promoting private trade in the marketing of agricultural commodities, which hitherto were controlled by the government through various marketing boards. The reform wave gained momentum in 1982, when the World Bank required the government to remove economic distortions as a condition of loans. The key policy intervention initiative came in 1986 with Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth (Kenya 1986). The sessional paper set out an economy wide growth strategy in which agriculture was meant to play a leading role in providing food security, creating employment to absorb the ever-increasing labor force, increasing export earnings, and facilitating rural industrialization. Sessional Paper No. 1 specified policies to enhance incentives for producers; to promote research, extension, credit, and input supplies; to expand the private sector; to rationalize expenditures in the public sector; and to undertake structural reform of parastatals and the civil service. Subsequent important government policy documents including the Development Plans (Kenya 1989, 1994a, 1997), the Sessional Paper No. 1 of 1994 on Economic Recovery and Sustainable Development to the Year 2010 (Kenya, 1994b), the Sessional Paper No. 2 of 1994 on National Food Policy (Kenya 1994c), and the Policy Framework Paper (Kenya 1996b) all emphasized the importance of these policy changes.

As alluded to earlier, initial agricultural policy reforms focused on liberalizing the agricultural market and removing price controls for all agricultural commodities. The government readily agreed to realign export crop prices to the world market prices, but reforms in the grain marketing system proved difficult to implement (Ikiara, Juma, and Amadi 1993). Other reform proposals put forward included decontrol and relaxation of the fertilizer import licensing system, price decontrol, and removal of obstacles in the marketing and distribution system. The implementation record of policy reforms during the 1980-1992 period was poor and characterized by considerable official ambiguity and covert and overt resistance (Ikiara, Juma, and Amadi 1993). While the government officially embraced agricultural and other economic reforms, it made only half-hearted efforts to implement them. For example, in grain marketing, the reforms emphasized restructuring the National Cereals and Produce Board (NCPB) to confine its role to the buyer and seller of last resort. The government insisted, however, on maintaining some central regulation and control for food security reasons. As a result, there was an on-and-off removal of controls until 1993, when the subsector was fully liberalized (albeit with the NCPB still involved in marketing alongside the private sector). To date, the role of the NCPB in the grain sector remains unclear, and considerable confusion remains about the level of government involvement.

1.2 Organization of the Maize Marketing System

Kenya's maize marketing system has evolved considerably since independence. With this evolution, the participation and roles of various marketing institutions have changed considerably. Today several types of market intermediaries exist. Figure 1 is a schematic representation of the maize marketing system showing the various marketing intermediaries and the links between them.

Seven major categories of market intermediaries can be identified: assemblers or bulk builders, wholesalers, retailers, disassemblers or bulk breakers, *posho* millers, large-scale millers, and the NCPB. Another category of traders could be identified by the use of intermediate means of transport (bicycles, oxcarts, donkeys, handcarts, and head load). These agents also purchase and bulk maize at the farm level and deliver it to assemblers, retailers, and *posho* millers. In contrast to the current marketing organization, Schmidt (1979) noted that during the era of market controls, the maize marketing system was separated into two interrelated subsystems. There was the formal state marketing agency, which was subject to controls, and the informal subsystem, which consisted of relatively small traders, mainly women, operating on a local level in the open-air markets where prices were not controlled. Other intermediaries identified by Schmidt (1979) included the *posho* miller, large-scale millers, cooperatives, wholesalers, retail shops, and brewers.

1.2.1 Characteristics of Maize Market Intermediaries

1) ***Assemblers (bulk builders):*** Assemblers are usually the first commercial purchasers of maize in the marketing chain. They usually begin as farmers who graduate to the next stage in the system by bulking up surpluses of neighboring farmers to capture scale economies in transport to local markets. All they require to enter into the maize business is to rent a stall or a shop, buy a weighing balance, and acquire a license from the county council. Assemblers buy maize from farmers, *bodaboda* (bicycle) traders, and donkey traders and then sell it to wholesalers, disassemblers, and retailers. Some assemblers, particularly in the surplus areas, act as purchasing agents

on behalf of the large-scale millers. Whereas assemblers are found in large numbers in the maize surplus areas, a few operate periodically in the deficit areas, where they purchase maize from the relatively smaller proportion of farmers with surplus production in these areas.

2) ***Wholesalers:*** Wholesalers are traders who buy maize from surplus districts (usually from assemblers) and transport the grain to deficit areas where they sell to disassemblers, retailers, or millers. Most wholesalers are also integrated backward into assembly; they purchase most maize in the postharvest months directly from farmers. Some of the wholesalers are involved in other businesses and join the maize trade only at the peak-harvesting season. In the peak harvest season, most wholesalers prefer to sell maize to the large-scale millers, who have the ability to buy large volumes and pay immediately. It also takes less time to sell to the millers than it does to sell directly to the retailers.
3) ***Disassembers (bulk breakers):*** Disassemblers buy maize from large-scale wholesalers in the deficit areas and break down the volumes for resale to smaller-scale retailers and final consumers. Disassemblers are usually local traders who normally operate in local shops and open-air periodic markets. Most of the disassemblers are also involved in maize retailing to consumers. Disassemblers also assemble maize during the short harvest period in the generally deficit areas in which they operate. Assemblers in the surplus regions likewise turn into disassemblers during the slack maize harvesting season, when some farmers run out of maize and begin purchasing for home consumption.
4) ***Retailers:*** These are market players who buy and sell maize in small quantities and directly sell to consumers for home consumption. They normally use *gorogoros* (two-kilogram tins) and are mainly found in deficit regions with a few of them in the low-income residential urban areas. The retailers in the surplus regions are sometimes overshadowed in business by the assemblers, who take over disassembling and retailing activities during slack period. In the deficit regions, these retailers purchase maize from disassemblers or directly from wholesalers.
5) ***Posho Millers***: This category of traders is involved in the processing of maize grain into whole maize meal. *Posho* millers employ a simple hammer-milling technology where the germ and the bran of the maize grain are milled together with the kernel into flour. *Posho* millers specialize in custom milling whereby the customer provides the grain. Most *posho* millers in the maize-surplus regions do more custom milling than production milling. Investment in *posho* milling has expanded rapidly in the postliberalization period, and over the past decade *posho* millers have acquired a significant proportion of the Kenyan maize meal market in urban and rural grain-deficit areas (Mukumbu and Jayne 1994; Jayne and Argwings-Kodhek 1997).
6) ***Large-scale millers***: Large-scale millers are processors who deal with large volumes of maize and do their own packaging. These millers are characterized by large-scale, capital-intensive roller-milling technology. Most of the large-scale millers are concentrated in the maize-deficit urban areas of Nairobi, Thika, Mombasa, and Kisumu, with only a few of them in the surplus urban areas of Kitale, Nakuru, and Eldoret. As shown in Figure 1, most millers acquire maize from wholesalers, farmers, and NCPB stores depending on the season. To cope with interseasonal variation in supply, millers have hired storage facilities, including NCPB silos where maize is stored. Of the total maize consumed in Kenya, three-quarters is in milled form (World Bank 1990). After milling, the main product, flour, and two by-products, germ and bran, are produced. Flour (sifted maize meal) is consumed mainly in the urban areas. *Posho* (whole maize meal) is consumed mainly in the rural areas and in the low-income urban areas. The large-scale millers have a wide network of wholesalers and retailers who distribute flour to the final consumers. The by-products are sold either

directly to dairy farmers as animal feed or to firms that reprocess them into poultry feed, animal feed, or corn oil. Some is sold to *chang'aa* brewers who offer attractive prices (Mukumbu 1992).

7) ***NCPB:*** The NCPB is a government parastatal that buys maize alongside the private sector. The NCPB used to operate a network of buying centers throughout the country, and it still has storage silos in major producing areas. With the advent of liberalization and the consequent reduction in state funding, however, the NCPB's role in the maize market has been greatly diminished. Occasionally during harvesting periods it opens a few seasonal buying centers in the major maize-surplus areas. Its main role is supposed to be stabilizing the market through engaging in commercial activities, maintaining strategic grain reserves, and managing famine relief supplies on behalf of the government. In recent years the government has intervened through the NCPB to support producer prices in response to pressure, mainly from large-scale producers. This action has sometimes resulted in the board's holding expensive stocks that it cannot profitably dispose of in competition with private traders.

1.3 Problem Statement and Significance

Food security cannot be achieved without an efficient food marketing system. Kenya continues to experience food shortages in general and maize shortages in particular. These shortages greatly compromise the welfare of Kenya's citizens, especially the poor. Persistent maize crises have generated considerable doubt regarding the efficiency of the entire food marketing and distribution system. For example, in 1998/99 the eastern parts of the country experienced maize shortages while at the same farmers in the Central Rift and Western Kenya had maize surpluses they could not dispose of because of low market prices.

After the 1998/99 crisis, it became clear that policy decisions have been made in an information vacuum. Despite the fact that maize marketing has been fully liberalized since 1993, there is little, if any, up-to-date empirical evidence regarding the efficiency of the maize marketing system. The role of infrastructure and other marketing institutions in influencing the efficiency of the system has not been documented. Our understanding of how the various actors in the maize marketing system have responded to market reforms and what constraints they face is still rudimentary.

Following the 1998/99 maize crisis and other problems in the grain sector (particularly the wheat and the rice subsectors) Technoserve and the U.S. Agency for International Development (USAID) sponsored an open forum that brought together leading scholars and stakeholders in the grain sector. The forum observed that the government's responses to crises in the grain sector often ended up hurting the intended beneficiaries (Technoserve 1999) because these responses were based on inadequate information. For instance, during the 1998/1999 season, following farmers' complaints about low producer prices, the government intervened in the maize market by providing the NCPB with KSh. 400 million to buy excess maize at KSh. 1,000 per bag. This intervention resulted in a massive rise in the consumer price and had a negative effect on food security in deficit areas such as Eastern and North Eastern Provinces, where maize became unaffordable to many Kenyans. The intervention was especially ill advised since the vast majority of Kenyan maize farmers buy more maize than they sell (Technoserve 1999). The government intervention ended up benefiting middlemen and large-scale farmers at the expense of consumers and peasant farmers.

This study seeks to understand the effects of recent liberalization policies on the efficiency of maize marketing. The performance of the maize marketing system is assessed using several measures of efficiency. These measures are the degree of market integration between surplus and deficit regions, the level of marketing costs, and the flow of price information. The importance of different infrastructure components is also examined. Components studied include storage facilities, market centers, financial institutions, market information systems, and transport infrastructure. The role of government policy in facilitating or impeding the private sector's ability to respond to liberalization is also addressed. The scope of the problems addressed is represented by the following questions: Has liberalization enhanced the efficiency of the maize marketing system? If so, what factors have contributed to efficiency? If inefficiencies remain, what are the limiting factors or constraints that undermine market performance?

Maize shortages in Kenya are usually attributed to the vagaries of climate. Most studies that address this issue tend to focus on the role of climatological factors without giving due attention to the role of the maize marketing system. This study attempts to fill this gap by providing an in-depth analysis of the maize marketing system.

Mittendorf (1993) observes that in many Sub-Saharan African countries policy changes eliminating market distortions and promoting competitive market systems have had a positive impact in promoting private business initiatives. In Kenya, however, marketing and institutional arrangements have mainly acted as disincentives to the private sector. Nyangito (1997) observes that the main constraint to the development of private trade in maize in Kenya is lack of supportive programs. For example, the Kenya Marketing Development Program (KMDP), which aimed at providing trading information and developing roads and marketing infrastructure (i.e.that is, material, institutional, and personal facilities and arrangements that allow production and movement of goods and services) was discontinued in 1995. Lack of information to market participants and poor access to markets remain problems. The NCPB has not achieved the objective of stabilizing market prices, and in some cases it has induced price instability. For instance, in the 1994/95 season it paid farmers higher prices than the ex-depot prices, and this step induced farmers to increase production for the 1995/96 season. The board, however, reduced its purchasing activities at harvest time and market prices subsequently fell below the floor price (Nyangito 1997). NCPB officials have intimated that the board is not adequately funded and runs out of funds whenever it attempts to intervene in the market.

Lack of appropriate physical infrastructure is also a major obstacle to the development of an efficient marketing system in Kenya. It is therefore important to identify the components of infrastructure that are necessary to encourage private trade in the maize sub sector to determine their potential contribution to the development of an efficient marketing system. Different infrastructure components are likely to affect the supply response of farmers and traders differently. The government should emphasize those components with the greatest impact on market access and marketing margins, for these factors can greatly influence incentives provided to the private sector. Achievement of this task, however, requires an understanding of the empirical interaction between infrastructure and maize marketing, information that is currently lacking in Kenya. This study assesses the potential impact of infrastructure on the development of private trade and on the efficiency of the maize marketing system.

Kenya has pursued market liberalization policies as part of its structural adjustment programs, with the objective of improving the functioning of markets. Restrictions on private trade, price controls, and consumer subsidies have been removed. The advent of liberalization has resulted in an increased interest in the role of private trade in food marketing, previously the preserve of state parastatals (Kenya 1994c, 1996b, 1997). To encourage the private sector to engage in this new role, the government must reform the institutions and policies that have impeded traders from participating in the marketing of maize.

This study is significant at two levels. It provides insights for both policymakers and policy analysts. Indicators such as the degree of market integration and the level of marketing costs are important inputs to government and nongovernmental agencies involved in food marketing in Kenya, as well as those agencies planning market improvement programs. Identifying the infrastructural and institutional factors and government policies that may have contributed to its inefficiency is the first step to instituting measures to improve the performance of the marketing system. Developing-country governments are often confronted with a fundamental dilemma between raising producer prices for food in order to encourage agricultural production and lowering consumer prices (at least in the short run) to protect consumers. Developing an efficient marketing system that moves food from farmers to consumers at the lowest cost is an essential policy goal. By minimizing marketing costs, an efficient system helps to ensure attractive producer prices and affordable consumer prices. Higher producer prices raise farm incomes, and low consumer prices enhance food accessibility, especially for the urban poor. Thus, the potential of an efficient marketing system to contribute to the Kenyan government's stated policy of poverty alleviation is indeed enormous.

For policy analysts, this study fills gaps in the maize marketing literature in Kenya. Although quite a number of studies focusing on pricing inefficiency of market controls were done in the preliberalization era (Hesselmark and Lorenzel 1976; Gsaenger and Schmidt 1977; Schmidt 1979; Maritim 1982; Ateng 1984; Olsen 1984; Food Supply Monitoring Project 1985; Kliest 1985; Meilink 1987; Argwings-Kodhek 1992; Gordon and Spooner 1992), limited work has been done on maize marketing in the postliberalization period. Only a few important studies have documented the pricing inefficiency of the system (such as Argwings-Kodhek 1994; Sasaki 1995; Ngugi, Mataya, and Ng'ong'ola 1997; Nyoro, Kiiru, and Jayne 1999). Most studies to date, however, fail to evaluate the role of factors such as infrastructure, institutions, market information, and government policy in influencing the efficiency of agricultural markets. Improvement in the maize marketing system can be achieved only if corrective measures that address the problems posed by these factors are instituted.

1.4 Purpose and Objectives

The overall purpose of this study is to evaluate the efficiency of Kenya's maize marketing system and to determine how infrastructure, policy, and actions of government and its agencies have influenced efficiency in the post liberalization period. Efficiency is assessed in terms of integration and level of marketing costs.

In order to achieve the broad objective, we address several specific questions:

- How well are surplus and deficit maize markets integrated, and how has liberalization affected integration?
- How have maize prices changed in response to the market reforms?
- What are the infrastructure constraints in the development of private marketing of maize?
- What has been the role of government in facilitating or impeding the private sector's ability to respond to market liberalization?

1.5 Research Hypotheses

In line with the research questions mentioned, this study tests several hypotheses. The first hypothesis is that liberalization has enhanced market efficiency as measured through integration of spatially separated maize markets. A second hypothesis is that producer prices have increased while consumer prices have declined. This situation might be a result of a reduction in marketing costs, which would in turn be the result of more open and competitive markets. A third hypothesis is that improved infrastructure has reduced marketing costs. And the final hypothesis is that government policy and actions of government and its agencies have had a negative effect on the performance of the marketing system.

2.0 RESEARCH METHODOLOGY

2.1 Overall Research Design

For the purpose of this study, we divided the country into four categories: major maize-surplus areas, minor maize-surplus areas, minor maize-deficit areas, and major maize-deficit areas. A preliminary analysis of maize production and consumption data on a district basis was used to classify districts as surplus or deficit areas. Further analysis using geographic information systems (GIS) allowed us to map the country into the four categories (Figure 2). Following the initial classification, four districts (one in each category) were chosen for the detailed study.

To ensure the representativeness of the districts chosen, the following additional factors were also taken into consideration:

- A district's importance as a production area and its contribution to the total domestically marketed maize production;
- A district's importance as a consumption area;
- The type of farmers in the district (large- and small-scale farmers);
- The potential flow of market information;
- The degree of infrastructure development (especially roads); and
- A district's rural or urban character.

Using these criteria, we chose four districts for the study: Trans Nzoia, Migori, Mbeere, and Nairobi (Figure 2). Table 1 shows these characteristics for the four districts.

Table 1--Characteristics of sampled districts

District	Trans Nzoia	Migori	Mbeere	Nairobi
Average maize production (tons)[a]	196,663	61, 900	9,768	2,350
Average maize consumption (tons)[b]	60,877	61,799	19,617	182,097
Road density (km/km^2)	0.48	0.63	0.38	3.30
Type of farmers	Large and small scale	Small scale	Small scale	Urban kitchen gardens
Rural/urban[c]	Rural	Rural	Rural	Urban

Source: Ministry of Agriculture Annual Reports (various issues), CBS (2000), District Development Plans (various issues).

a. Average production for 1992-2000, 1993-2000, 1995-1999, and 1998-2000 for Trans Nzoia, Migori, Mbeere, and Nairobi, respectively.
b. Average consumption for 1992-2000 for Trans Nzoia, Migori, and Nairobi and 1995-2000 for Mbeere.
c. A district was classified as rural or urban on the basis of population density and whether main activities are agricultural or nonagricultural (see Carter 1995).

Trans Nzoia District, in the Rift Valley Province, lies in the western region of the country, which is often referred to as the country's maize granary. The region produces about 60 percent of the country's average annual total production of 2.7 million metric tons of maize and contributes about 90 percent of the marketed production of 0.5 million metric tons. Trans

Nzoia District alone accounts for approximately 40 percent of the total marketed maize production in the country (Nyangito and Ndirangu 1997). The district has both large-scale and small-scale producers who grow maize for commercial purposes. The latter are typical of most commercial small-scale producers in the country, who use low levels of commercial inputs and produce for both subsistence and commercial purposes. In view of the dominant role that Trans Nzoia plays as a maize producer in the country and its impact on the national maize market, we would expect producers and traders in the district to have developed a good information network on the functioning of the maize market. We therefore chose the district to represent the major surplus areas.

In Migori District in Nyanza Province small-scale farmers grow maize both as a food and as a cash crop. In contrast to Trans Nzoia, farmers and traders in Migori would be expected to have a less-developed market information network since the district accounts for a small proportion of the marketed surplus in the country. It was chosen to represent the minor surplus areas.

Mbeere District in the Eastern Province is a typical rural district in Kenya that is poorly served internally in terms of infrastructure. Consequently, market information flow in the district is expected to be inadequate. It produces relatively little maize, and, because of its relatively low population, it is not a major consumption area. The district was chosen to represent the minor deficit regions.

Nairobi is an extra provincial urban district and the major maize-consuming area in the country. The district, with approximately 7.5 percent of the country's population, consumes about 8 percent of the national maize intake (CBS 2000; Ministry of Agriculture 1999). Nairobi is the main commercial center and seat of government and the infrastructure (such as roads and telecommunications) is fairly well developed in contrast to the rural districts of Kenya. As a result market information flow is expected to be quite good. Nairobi was chosen to represent the major deficit areas.

A sampling design for respondents was developed on the basis of the number of market sites in each district, the number and kind of traders in each market site, the volume of maize handled by individual traders, and other relevant characteristics of the markets. Information on these market characteristics was generated during a reconnaissance survey. Sixty traders in each of the four selected districts were sampled for interviews, giving a total sample of 240 traders. Data from 234 respondents are used for the analysis. The other six questionnaires provided incomplete information.

2.2 Sources of Data

Secondary data on maize production and consumption were obtained from the Ministry of Agriculture. The ministry's method of calculating maize consumption was used to calculate consumption of maize in the various districts of Kenya (Ministry of Agriculture 1999). The method assumes that each urban and rural consumer respectively consumes 98 and 117 kilograms of maize annually. Multiplying the estimated per capita consumption by the population in a district gives an estimate of total consumption.

Maize price data were obtained from various sources including the Central Bureau of Statistics, Ministry of Agriculture reports, the NCPB, and other published sources. Most of the price data collected could not be used, as many of the series were incomplete. Attempts to combine different sources were plagued by inconsistencies in methods of data collection among the various agencies. No single source yielded a usable time series. A small number of markets with minor gaps in data series were used to construct complete time series. Gaps were filled by combining data from various sources, and occasionally, where only one data point was found to be missing, by interpolating through averaging the preceding and succeeding observations. Nine data points and no more than two for each of the six series were filled this manner. The problem of data inconsistency and missing observations was particularly acute for the preliberalization period, hence the short period considered. Usable price series were constructed for six markets: Kitale in Trans Nzoia, Migori and Awendo in Migori, Kiritiri and Siakago in Mbeere, and Nairobi.

Primary data on marketing costs were collected from maize traders in market sites in the four districts chosen for this study. These sites are listed in Table 2.

Table 2--Maize marketing study sites

Zone	District	Study sites
Major surplus zone	Trans-Nzoia	Gituamba, Endebess, Kesogon, Sibanga, Kitale, Kachibora Kiminini
Minor surplus zone	Migori	Muhururu, Sori, Olasi, Wath Ong'er, Giribe, Bondo Nyironge, Mukuro, Migori Town, Ogwedhi, Kakrao, Oria, Oyani Maasai, Awendo, Dede, Rongo, Opapo
Minor deficit zone	Mbeere	Ishiara, Siakago, Kiritiri, Karaba, Makima, Ngiri, Kanyuambora, Kerii, Gachuriri, Makutano
Major deficit zone	Nairobi	Kibera, Kawangware, Nyamakima, Gikomba, Kangemi, Korogocho, Githurai, Kahawa West

Source: Authors' survey, 2001.

A structured questionnaire was used to collect information on infrastructure and government policies in facilitating or impeding the private sector's ability to respond to liberalization. Informal interviews with key informants in maize marketing provided general information on the maize subsector. In particular, discussions were held with key personnel in the policy decision making process, including officials in the Ministries of Agriculture, Finance, Planning and National Development, Office of the President, and NCPB. These discussions served two important purposes. First, the officials provided important insights into the policymaking and implementation process as it relates to the maize subsector. Second, the interviews served to create awareness on the part of the officials about the study. We hope that this awareness will enhance goodwill and increase the likelihood that the results of the study will be applied in the policymaking process.

2.3 Methods of Data Analysis

2.3.1 Preamble

Liberalization of agricultural markets affects the nature and efficiency of the market itself. Reform has observable effects on, among other things, agricultural price levels, the extent of price transmission between markets or market integration, the stability or volatility of market prices, changes in the size of marketing margins, and investments by private traders and other efforts to improve the functioning of markets (Kherallah et al. 2002). This study addresses a number of these issues through a comparative analysis of the preliberalization and postliberalization periods.

2.3.2 Effects of Liberalization on Prices

Initial analysis of price data focused on summary statistics and plots of price trends. We computed marketing margins, defined in this study as the difference between prices in surplus areas (representing producer price) and deficit areas (representing consumer price), and attempted to compare their behavior between the pre- and postliberalization periods. . Marketing margins would be expected to decline with liberalization, due to either a decline in consumer prices, an increase in producer prices, or both. If marketing margins declined, they would indicate that the private traders were effectively engaging in spatial arbitrage.

Price volatility (as manifested by excessive price variability) was examined to detect whether or not there was effective temporal arbitrage before and after market liberalization. Volatility was assessed by computing the coefficients of variation for the two periods. Volatile prices would indicate a lack of temporal arbitrage. Traders and farmers will fail to store grain if they lack appropriate storage facilities and technologies or they are unwilling to engage in temporal arbitrage because of perceived market risk. Effective temporal arbitrage would, on the other hand, serve to stabilize prices.

2.3.3 Effects of Liberalization on Market Integration

Market integration concerns the free flow of goods and information over form, space, and time and is thus closely related to concepts of efficiency. Spatial integration relates to spatially distinct markets. If two markets are integrated, a shock to the price in one market should be manifest in the other market price as well. Among perfectly segmented markets, price series should be independent. Comovement of prices has thus become synonymous with market integration (Barret 1996). This observation underscores the usefulness of market integration studies in evaluating the efficiency of markets. As Barret (1996) observes, however, market analysis depends on available data. Advances in economists' toolkits for market analysis, though dramatic in the last two decades, have not been accompanied by concomitant emphasis on the collection of relevant data in developing countries. Often, analysts must use the more easily accessible price data to carry out market analysis studies. Although models requiring transaction cost and trade flow data (Barrett 1996) hold promise, they are not easily implemented because of a lack of this kind of data.

In the current study, market integration was analyzed by considering whether prices from geographically different locations move together in systematic ways over time. Several models, which are discussed later, were employed to study market integration. Monthly price data were divided into pre- and postliberalization periods. The preliberalization data set covered the period between January 1991 and December 1993, and the postliberalization set covered the period between January 1994 and December 1999. Prices were studied using simple correlation, bivariate correlation of price differences, and cointegration techniques.

In addition, the direction of causality in maize prices was examined using the Granger causality test. Granger causality is a useful approach in determining whether price movements follow well-defined paths--that is, start around demand or production centers and then spread around the country. Testing for causality among commodity markets determines the existence of central markets (Goletti and Babu 1994). The presence of central markets would invariably mean that there is radial transmission of prices and price changes. Analyses for the periods before and after liberalization were used to indicate how liberalization has affected integration of maize markets and the location of central markets.

Price-series correlations are convenient measures of market integration since they rely only on price data, which are more readily available than the cost data required to evaluate intermarket price differentials. Many researchers, however, have argued against the use of the correlation coefficients to measure market integration as it is fraught with problems. Goletti and Babu (1994), for instance, have noted that correlation coefficients mask the presence of other synchronous factors, such as general price inflation, seasonality, population growth, and procurement policy. This shortcoming has led to a proliferation of other methods for testing market integration. In this study, therefore, we considered a second measure of integration, the bivariate correlation of price differences. The use of price differences is based on the observation that market integration could be interpreted as interdependence of price changes. Using price differences removes the nonstationarity and common time trends present in price levels solves the problem of spurious correlation. A third approach for testing market integration is the cointegration approach. This approach examines whether two markets are integrated in the long term by assessing whether their prices fluctuate within a fixed band. It is assumed that prices move together, subject to various individual shocks that may cause temporary divergences. If, in the long run, they exhibit a linear constant relation, then they are said to be cointegrated. In general, a pair of price series X_t and Y_t is said to be cointegrated if the series are individually of the same order of economic integration and there exists a linear combination of the series such that the measure

$$\varepsilon_1 = Y_t - \alpha - \beta X_{t,} \tag{1}$$

is stationary or integrated of order zero (Engle and Granger 1991). Such integration is abbreviated as $I(0)$. A two-step, residual-based test due to Engle and Granger (1987) is often used to assess whether pairs of markets are integrated. In the first step, price series are tested for unit roots using the augmented Dickey-Fuller (ADF) test to establish the order of economic integration. The order of economic integration is the number of times the series needs to be differenced before it is transformed into a stationary series. Once the order of economic integration is established, the next step is to test for cointegration of the price series. To test for cointegration, "cointegrating regressions" are estimated by ordinary least squares (OLS), that is prices in market i, $P_{i,t}$, are regressed on prices in market j, $P_{j,t}$, thus:

$$P_{i,\ t} = \alpha_0 + \ \delta_1 P_{j,\ t} \ + \ e_t \tag{2}$$

The residuals from this regression are then tested for the presence of unit roots. In theory, if market i is cointegrated with market j, then market j should be cointegrated with market i. In practice, however, test results may differ. For this reason cointegration tests are typically repeated for all the markets, interchanging the left-hand and right-hand price variables (Ngugi, Mataya, and Ng'ong'ola 1997).

To test for Granger causality, Goletti and Babu (1994) suggest the following error correction model:

$$\Delta P_{i,t} = \alpha_o^i + \alpha_1^i P_{i,\ t-1} + \alpha_2^i P_{j,\ t-1} + \sum_{k=1}^{k=m_i} \delta_k^i \Delta P_{i,\ t-k} + \sum_{h=0}^{h=n_i} \lambda_h^i \Delta P_{j,\ t-h} \tag{3}$$

where: Δ is the difference operator; m_i and n_i are the number of lags; and the α's, δ's and λ's are parameters to be estimated.

The variables in the model should first be confirmed to be stationary. Cointegration implies Granger causality in at least one direction, but this relationship may be violated depending on the number of missing values in the cointegration model and the error correction model. If price movements in market *j* precede price movements in market *i,* then the $\Delta P_{i,\ t-m}$ terms should have a significant effect on $\Delta P_{i,\ t}$. To verify the existence or otherwise of Granger causality, an F-test is conducted on the null hypothesis that the coefficients α^i_2, and λ^i_h (h= 1,…,n_i) are jointly equal to zero.

2.3.4 Infrastructure and Government Policy

Data collected from traders using the structured questionnaire were studied to learn how traders perceive the role of government in influencing maize marketing. Results indicate the number and proportion of traders (and their characteristics) citing a particular factor as an impediment to the efficient marketing of maize. The issues considered important in facilitating or impeding the private sector response to liberalization include infrastructure (road network, rural feeder roads, storage facilities, and market centers), flow of market information, capital and credit availability, government rules and regulations, and an uncertain policy environment.

3.0 RESULTS AND DISCUSSION

3.1 Effects of Liberalization on Prices

Nominal maize prices in surplus and deficit regions exhibited an increasing trend and substantial fluctuations in both the pre- and postliberalization eras. Real prices, however, exhibited a slightly declining trend suggesting that liberalization may lead to reduced consumer prices for maize. Figure 3 presents the trends in nominal maize price series for Kiritiri and Siakago markets in Mbeere District, Kitale in Trans Nzoia District, Nairobi, and Migori and Awendo in Migori District. Some summary statistics of the prices are presented in Table 3. The mean nominal price was significantly higher at the 1 percent level in the postliberalization period than in the preliberalization period. Real prices showed no significant differences between the two periods. In addition, prices exhibited higher variability in the postliberalization period as indicated by the larger ranges and lower coefficients of variation.

The increase in price volatility after liberalization suggests that traders have not engaged in effective temporal arbitrage that could stabilize prices. Traders and farmers have failed to store grain owing to a lack of appropriate storage facilities and technologies and to a perceived market risk as reported later in this report.

Table 3--Summary statistics of price series (KSh.)

Market	Era	Maximum	Minimum	Mean	Standard deviation	CV[a]
Kiritiri	Preliberalization	1,120	200	518	282	0.54
	Postliberalization	1,800	400	1,052*	389	0.37
Siakago	Preliberalization	1,200	200	529	295	0.56
	Postliberalization	1,800	480	1,072*	391	0.36
Kitale	Preliberalization	941	283	557	201	0.36
	Postliberalization	1,840	450	939*	320	0.34
Nairobi	Preliberalization	1,200	320	657	280	0.43

	Postliberalization	1,626	684	1,113*	273	0.25
Migori	Preliberalization	950	230	602	238	0.40
	Postliberalization	2,120	400	1,020*	414	0.41
Awendo	Preliberalization	1,052	280	532	227	0.43
	Postliberalization	1,535	480	1,079*	295	0.27

Source: Authors' survey, 2001.
* Significantly different (1%) from the corresponding preliberalization figure.
[a] CV = coefficient of variation.

An attempt to study trends in price spreads by considering prices in the surplus and deficit markets was unsuccessful, as the difference between the two does not constitute current marketing costs. It was found that in some cases prices in surplus areas were higher than those in deficit areas. This finding suggests the occurrence of interseasonal commodity flow reversals. Instead, to gain some understanding of how prices in different markets were related, an assessment of the degree of market integration was carried out.

3.2 Effects of Liberalization on Market Integration

3.2.1 Correlation Analysis

As indicated earlier, several models were employed for the purpose of analyzing market integration. The first step involved computing simple correlation coefficients for pairs of price series. The results of correlation analysis of price levels are presented in Tables 4a and 4b. The simple correlation coefficients are quite high, ranging between 0.718 and 0.987 in the preliberalization period and between 0.522 and 0.899 in the postliberalization period. An interesting observation is that all the correlation coefficients in the preliberalization period are greater than the corresponding coefficients in the postliberalization period. Markets close to each other, such as Kiritiri and Siakago, show higher correlation coefficients, as do markets that are connected by better transport infrastructure, such as between Nairobi and most of the other markets. The results seem to support the generally accepted notion that shorter distances and improved infrastructure among markets lead to lower transaction costs, making arbitrage profitable and thereby enhancing integration of such markets.

Table 4a--Correlation matrix of price levels in the preliberalization era

	Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
Kiritiri	1.000					
Siakago	0.987	1.000				
Kitale	0.718	0.749	1.000			
Nairobi	0.849	0.846	0.877	1.000		
Migori	0.750	0.760	0.829	0.891	1.000	
Awendo	0.795	0.760	0.719	0.874	0.747	1.000

Table 4b--Correlation matrix of price levels in the postliberalization era

	Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
Kiritiri	1.000					
Siakago	0.835	1.000				
Kitale	0.600	0.616	1.000			
Nairobi	0.765	0.832	0.899	1.000		

Migori	0.522	0.601	0.793	0.787	1.000	
Awendo	0.649	0.680	0.826	0.833	0.828	1.000

Source: Authors' survey, 2001.

As noted, the use of the correlation coefficients approach to measure market integration is fraught with problems. This study therefore considered, as a second measure of integration, the bivariate correlation of price differences. This approach addresses the problem of spurious correlation that is associated with correlation analysis. The correlation coefficients of price differences are reported in Tables 5a and 5b. The coefficients are much lower than those of the price levels. They range from –0.152 for the Migori-Awendo market link to 0.966 for the Kiritiri-Siakago link in the preliberalization period. In the post-liberalization period the lowest correlation coefficient is for the Kitale-Siakago link (-0.186) while the highest is for the Migori-Awendo link (0.436). The results suggest that the degree of integration is much lower than can be deduced from the correlation matrix of price levels. Note that markets that appear to have high degrees of integration on the basis of one measure appear not to be integrated when another measure is employed. This observation highlights the pitfalls of relying on one measure to evaluate market integration and underscores the need to consider alternative approaches to studying various aspects of the price transmission process. It is this consideration that led to the use of the cointegration approach in this study, as presented in the next section.

Table 5a--Correlation matrix of price differences in the preliberalization era

	Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
Kiritiri	1.000					
Siakago	0.966	1.000				
Kitale	0.378	0.368	1.000			
Nairobi	0.520	0.545	0.565	1.000		
Migori	0.070	0.054	0.038	0.398	1.000	
Awendo	0.067	-0.033	0.393	0.047	-0.152	1.000

Table 5b--Correlation matrix of price differences in the postliberalization era

	Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
Kiritiri	1.000					
Siakago	0.406	1.000				
Kitale	-0.091	-0.186	1.000			
Nairobi	0.131	0.372	0.419	1.000		
Migori	-0.146	0.122	0.130	0.292	1.000	
Awendo	0.121	-0.015	0.197	0.367	0.436	1.000

Source: Authors' survey, 2001.

3.2.2 Cointegration Analysis

The two-step, residual-based test due to Engle and Granger (1987) was carried out by first testing for unit roots in the price series. The results are presented in Tables 6a and 6b. Again the sample was divided into the pre- and postliberalization periods. Price levels were tested for unit roots using the ADF test. There were two sets of results. The first set presents ADF statistics for models with an intercept term but no trends, and the second set gives the ADF statistics for models with an intercept and linear deterministic trend. Often the choice of the model depends on whether or not the analyst believes the series is trended. It is expected that maize price series are trended, but we include the results of the nontrended model for comparison. Thus the equations estimated were:

$$\Delta P_{i,\ t} = \alpha_0 + \delta_1\ P_{i,\ t-1} + \sum_{m=1}^{m=n}\ \alpha_m\,\Delta P_{i,\ t-m} + U_t \tag{4}$$

$$\Delta P_{i,\ t} = \alpha_0 + \delta_1\ P_{i,\ t-1} + \sum_{m=1}^{m=n}\ \alpha_m\,\Delta P_{i,\ t-m} + \beta_1 T + U_t \tag{5}$$

The values reported in Table 6a show that most of the regressions with and without trend are of the order zero of augmentation (*p* in the tables) while Nairobi (with trend) is of order one and Migori (with trend) of order two. Table 6b shows that the postliberalization Kiritiiri series without trend is of order one. Nairobi and Kitale series with and without trend are are of order two. All other regressions are of order zero. The order of augmentation was determined by using combinations of three criteria: Akaike's information criterion (AIC), Schwarz Bayesian criterion (SBC), and Hannan-Quinn criterion (HQC). All ADF statistics, except in the case of Kiritiri, are (in absolute value) below their asymptotic 95 percent critical values given in the last two rows of Tables 6a and 6b. It is therefore not possible to reject the null hypothesis of unit roots in the price level series at the 5 percent significance level. Considering the results in Table 6a, it was observed that maize series were integrated of order one--that is, $I(1)$ in the preliberalization era. Similar tests for the postliberalization period yield results similar to those of the preliberalization era except that the hypothesis of presence of unit root is rejected for the Kiritiri price series (Table 6b). There is no reason to believe that the Kiritiri price series is structurally different from the other price series, and therefore we are compelled by caution to interpret all the price series as nonstationary--that is, not integrated of degree zero.

Table 6a--Unit root tests for price series in the preliberalization era

Market	*p*	Criterion	ADF test statistic	Null hypothesis (unit root present)
Kiritiri (no trend)	0	AIC, SBC, HQC	-1.563	Cannot reject
Kiritiri (with trend)	0	AIC, SBC, HQC	-1.680	Cannot reject
Siakago (no trend)	0	AIC, SBC, HQC	-1.422	Cannot reject
Siakago (with trend)	0	AIC, SBC, HQC	-1.505	Cannot reject
Kitale (no trend)	0	AIC, SBC, HQC	-2.144	Cannot reject
Kitale (with trend)	0	SBC, HQC	-2.110	Cannot reject
Nairobi (no trend)	0	AIC, SBC, HQC	0.026	Cannot reject
Nairobi (with trend)	1	AIC, SBC, HQC	-1.965	Cannot reject
Migori (no trend)	0	SBC, HQC	-1.645	Cannot reject
Migori (with trend)	2	AIC, SBC, HQC	-2.833	Cannot reject
Awendo (no trend)	0	AIC, SBC, HQC	-0.933	Cannot reject
Awendo (with trend)	0	AIC, SBC, HQC	-2.235	Cannot reject
95% critical value for the ADF statistic (no trend)			-2.997	
95% critical value for the ADF statistic (with trend)			-3.662	

The next step involved differencing the price series and repeating the unit root test on the price differences. The equations estimated were:

$$\Delta^2 P_{i,\,t} = \alpha_0 + \delta_1\ P_{i,\,t-1} + \sum_{m=1}^{m=n} + \ \alpha_m\,\Delta^m P_{i,\,t-m}\ \ U_t \tag{6}$$

$$\Delta^2 P_{i,\,t} = \alpha_0 + \delta_1\ P_{i,\,t-1} + \sum_{m=1}^{m=n} + \alpha_m\,\Delta^m P_{i,\,t-m} + \beta_1\ T\ \ U_t \tag{7}$$

The model selection criteria suggest orders of augmentation of between zero and two with most regressions being of order zero. In all cases, and regardless of the order of augmentation chosen, the computed ADF statistics are well above the 95 percent critical value of the test given at the last two rows of Tables 7a and 7b. Hence the hypothesis that the first differences of the price series have unit roots is firmly rejected. From the evidence provided by this test, it was concluded that the price series are integrated of order one--that is, all price series are *I*(1). Once the order of economic integration was established, the next step was to test for cointegration of the price series.

Table 6b--Unit root tests for price series in the postliberalization era

Market	*p*	Criterion	ADF test statistic	Null hypothesis (unit root present)
Kiritiri (no trend)	1	AIC, HQC	-3.434	Reject
Kiritiri (with trend)	0	SBC, HQC	-3.682	Reject
Siakago (no trend)	0	AIC, SBC, HQC	-1.973	Cannot reject
Siakago (with trend)	0	AIC, SBC, HQC	-2.387	Cannot reject
Kitale (no trend)	2	AIC, HQC	-2.838	Cannot reject
Kitale (with trend)	2	AIC, SBC, HQC	-3.142	Cannot reject
Nairobi (no trend)	2	AIC, HQC	-2.115	Cannot reject
Nairobi (with trend)	2	AIC, HQC	-2.400	Cannot reject
Migori (no trend)	0	AIC, SBC, HQC	-2.153	Cannot reject
Migori (with trend)	0	AIC, SBC, HQC	-2.426	Cannot reject
Awendo (no trend)	0	AIC, SBC, HQC	-1.590	Cannot reject
Awendo (with trend)	0	AIC, SBC, HQC	-1.845	Cannot reject
95% critical value for the ADF statistic (no trend)			-2.902	
95% critical value for the ADF statistic (with trend)			-3.472	

Source: Authors' survey, 2001.

Table 7a--Unit root tests for first differences of prices in the preliberalization era

Market	*p*	Criterion	ADF test statistic	Null hypothesis (unit root present)
Kiritiri (no trend)	0	AIC, SBC, HQC	-4.652	Reject
Kiritiri (with trend)	0	AIC, SBC, HQC	-4.566	Reject
Siakago (no trend)	0	AIC, SBC, HQC	-4.255	Reject
Siakago (with trend)	0	AIC, SBC, HQC	-4.187	Reject
Kitale (no trend)	0	AIC, SBC, HQC	-4.198	Reject
Kitale (with trend)	0	AIC, SBC, HQC	-4.163	Reject
Nairobi (no trend)	0	AIC, SBC, HQC	-2.317	Cannot reject
Nairobi (with trend)	1	AIC, SBC, HQC	-2.164	Cannot reject
Migori (no trend)	0	AIC, SBC, HQC	-3.803	Reject
Migori (with trend)	0	AIC, SBC, HQC	-3.777	Reject
Awendo (no trend)	0	AIC, SBC, HQC	-4.476	Reject
Awendo (with trend)	0	AIC, SBC, HQC	-4.314	Reject
95% critical value for the ADF statistic (no trend)			-3.004	
95% critical value for the ADF statistic (with trend)			-3.633	

Source: Authors' survey, 2001.

Table 7b--Unit root tests for first differences of prices in the postliberalization era

Market	*p*	Criterion	ADF test statistic	Null hypothesis (unit root present)
Kiritiri (no trend)	1	AIC, HQC	-8.373	Reject
Kiritiri (with trend)	1	AIC, HQC	-8.365	Reject
Siakago (no trend)	0	AIC, SBC, HQC	-9.779	Reject
Siakago (with trend)	0	AIC, SBC, HQC	-9.812	Reject
Kitale (no trend)	0	SBC, HQC	-7.134	Reject
Kitale (with trend)	0	SBC, HQC	-7.083	Reject
Nairobi (no trend)	0	AIC, SBC, HQC	-6.116	Reject
Nairobi (with trend)	0	AIC, SBC, HQC	-6.101	Reject
Migori (no trend)	0	AIC, SBC, HQC	-9.143	Reject
Migori (with trend)	0	AIC, SBC, HQC	-9.082	Reject
Awendo (no trend)	0	AIC, SBC, HQC	-8.420	Reject
Awendo (with trend)	0	AIC, SBC, HQC	-8.360	Reject
95% critical value for the ADF statistic (no trend)			-2.902	
95% critical value for the ADF statistic (with trend)			-3.472	

Source: Authors' survey, 2001.

To test for cointegration, residuals were obtained from regressions of the price in market *i*, $P_{i,t}$ on the price in market *j*, $P_{j,t}$ as given already in equation 2. The residuals were then tested for the presence of unit roots. If the *t*-value for δ_1 is greater than the critical 95 percent level ADF statistic, the residuals are integrated of order zero and the prices are cointegrated. Again as noted earlier, in theory, if market *i* is cointegrated with market *j,* then market *j* should be cointegrated with market *i*. In practice, however, test results may differ. For this reason the cointegration test was repeated for all markets by interchanging the left-hand and right-hand price variables.

Results are presented in Tables 8a and 8b with the first column showing the dependent variable in the first regression and the first row representing the dependent variable of the second regression. According to Engle and Granger (1991) a link between market *i* and market *j* is said to be segmented if there is no cointegration in either direction, or rather if regressing series *i* on series *j* and regressing *j* on *i* both yield nonstationary residuals. This implies that if there is cointegration in at least one direction, then the link is considered to be integrated. Following this argument, the cointegration tests show that for the preliberalization sample the hypothesis of cointegration of OLS residuals is rejected only for the Kiritiri-Siakago, Kitale-Nairobi, Kitale-Migori, and Nairobi-Migori links. This implies that all other markets were not integrated in the preliberalization period. The result highlights the importance of the restriction that limited the amount of grain that could be moved out of a district in the era of market controls. In the postliberalization period the hypothesis of no long-term relations among pairs of markets is rejected in all cases except for the Nairobi-Awendo, Siakago-Migori, and Siakago-Awendo. We concluded that only the three market links listed were not cointegrated in the postliberalization period considered in this study.

Dividing the sample into preliberalization and postliberalization subsamples and carrying out the appropriate cointegration tests led us to observe that most markets became cointegrated in the postliberalization era. We conclude that liberalization improved the transmission of price signals among various markets in the country, thereby strengthening the links between markets.

Table 8a--Unit root tests for OLS residuals in the preliberalization era

	Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
Kiritiri	-----	Reject	Cannot reject	Cannot reject	Cannot reject	Cannot reject
Siakago	Reject	-----	Cannot reject	Cannot reject	Cannot reject	Cannot reject
Kitale	Cannot reject	Cannot reject	-----	Reject	Reject	Cannot reject
Nairobi	Cannot reject	Cannot reject	Cannot reject	-----	Reject	Cannot reject
Migori	Cannot Reject	Cannot reject	Reject	Reject	-----	Cannot reject
Awendo	Cannot reject	Cannot reject	Cannot reject	Cannot reject	Cannot reject	-----

Source: Authors' survey, 2001.

Table 8b--Unit root tests for OLS residuals in the postliberalization era

	Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
Kiritiri	-----	Reject	Reject	Reject	Reject	Reject
Siakago	Reject	-----	Reject	Reject	Cannot reject	Cannot reject
Kitale	Reject	Reject	-----	Reject	Reject	Reject
Nairobi	Reject	Reject	Reject	-----	Cannot reject	Cannot reject
Migori	Reject	Cannot reject	Reject	Reject	-----	Reject
Awendo	Reject	Cannot reject	Reject	Cannot reject	Reject	-----

Source: Authors' survey, 2001.

Having established cointegration of various markets in the postliberalization era, we proceeded to assess whether price movements follow well-defined paths--that is, start around demand or production centers and then spread around the country using the Granger causality test as explained in section 2.3.3. The results of this test are presented in Table 9. The reader is reminded that Granger causality tests were undertaken for those market links where cointegration in the postliberalization era had been established.

Table 9--F-statistics for the Granger causality tests

		Market *j*					
		Kiritiri	Siakago	Kitale	Nairobi	Migori	Awendo
	Kiritiri	-	22.28	3.41	10.67	3.23	4.84
	Siakago	21.67	-	4.47	5.46	X	X
Market i	Kitale	2.85	1.35	-	26.95	9.65	10.76
	Nairobi	4.91	6.03	27.14	-	7.77	X
	Migori	0.63	X	15.52	9.39	-	13.79
	Awendo	2.57	X	9.51	X	10.70	-

Source: Authors' survey, 2001.
Note: X denotes market links that are not cointegrated.

The results show that most markets exhibit bidirectional causality (feedback causality) except that Siakago does not. Granger causes Kitale, and Kiritiri does not cause Migori. Nairobi, Kitale, and Kiritiri appear to be important markets in terms Granger causing other markets. The issue of Granger causality has also been examined for the Ethiopian markets by Negassa (1998). The findings point at Addis Ababa as a central market that Granger causes prices for teff, wheat, and maize in the other markets. It would appear that markets in important production and consumer zones usually emerge as central markets following reforms and market liberalization.

Liberalization and integration by themselves cannot guarantee market efficiency. For example in Malawi, Goletti, and Babu (1994) note that while liberalization has enhanced market integration, the extent and speed of price transmission still remains low, a phenomenon they attribute to underdeveloped market infrastructure. In Ethiopia, Negassa (1998) has shown that market integration exists alongside high spatial price differentials. This finding again is attributed to poor market infrastructure in terms of transport, storage, and market information. Almost universally, private sector agents are constrained by limited access to credit and storage facilities, as well as problems in securing transport (Beynon, Jones, and Yao 1992; Badiane and Shively 1998).

Coulter (1994) argues that the reform process in Africa has tended to emphasize pricing policy rather than complementary investments in infrastructure and services. Coulter and Compton (1991) identified the following constraints facing the operation of liberalized marketing systems in Africa:

- Inadequate roads and vehicles;
- Lack of availability of trade credit;
- Lack of storage chemicals;
- Lack of market information;
- Unsupportive legal frameworks;
- Lack of commitment by governments; and
- Inconsistent donor support;

Among these factors, lack of government commitment presents the most important obstacle. Many African governments perceive liberalization as a risky process, and the process has thus been severely constrained by lack of domestic political consensus (Booth 1994; Badiane and Shively 1998; Jones, 1998).

The overall picture emanating from the analysis of marketing efficiency presented so far is that of a country where liberalization has enhanced market integration between maize surplus and deficit areas. The degree of market efficiency, however, is still low and can be improved. Market liberalization alone cannot achieve a structural change in market integration unless concomitant investments in marketing infrastructure (such as transportation and communication) are undertaken. A stable and certain government policy is also necessary for improvement in market efficiency. Consequently, this study further analyzed the role of different infrastructure components including storage facilities, market centers, financial institutions, market information systems, and transport infrastructure in enhancing the efficiency of the maize marketing system. The role of government policy in facilitating or impeding the private sector's ability to respond to liberalization was also addressed.

3.3 The Role of Infrastructure and Government Policy in Maize Marketing

Infrastructure is generally defined as material, institutional, and personal facilities and arrangements that allow production and movement of goods and services (Thimm 1993). As Jayne et al. (1997) note, food markets in Africa are characterized by small-scale trader operations, limited trader investment in transport and storage, and the slow pace of private market development. This section identifies the role of different infrastructure components in influencing the efficiency of the maize marketing system in Kenya. Specifically, the role of transport, storage, market centers, and other marketing facilities in promoting the participation of private traders in the maize marketing system is considered.

3.3.1 Transport Infrastructure

As shown in Table 10, about 79 percent of the sampled traders used dry-weather roads, which are normally impassable during the wet season, to move maize from the farms to the markets. These dry-weather roads are mainly in the rural districts of Trans Nzoia, Mbeere, and Migori. A wide variety of transport modes used by private maize traders were identified. These include long-distance lorry haulers, bicycles *(bodabodas*), pickup trucks, donkeys, oxcarts, handcarts, head loads, and tractors. The relative importance of the various modes of transporting maize is indicated in Figure 4.

About 66 percent of the sampled traders reported that the road network is not well developed for easy transportation of maize. Maize traders encounter a number of problems when transporting their maize, including poorly maintained roads with potholes, high maize transport costs, insecurity, and impassable, dry-weather-only roads. Table 11 shows a ranking of these problems on basis of the number of traders that considered each of them as the most important. I t was observed that the perception of the severity of each problem varied by type of trader as depicted in Table 12. Opinions were varied about how the transport problems could be solved. As shown in Figure 5, the majority of the traders wanted the road network improved through tarmacking of the dry-weather roads and regular maintenance of the existing roads.

Table 10--Types of roads used to transport maize to local markets

District	Number of traders who report using:	
	All-weather roads	Dry-weather roads
Mbeere	10	35
Nairobi	16	8
Trans Nzoia	-	51
Migori	12	47
Total	38 (20.8%)	141 (79.2%)

Source: Authors' survey, 2001.

Table 11--Transport problems reported by traders

Problem	Number of traders	%

	reporting problem	
Poorly maintained roads (with potholes)	50	21.4
High transport costs	40	17.1
Muddy access roads	40	17.1
No problem	34	14.5
Does not transport maize	27	11.5
No means of transport	18	7.7
Insecurity	13	5.6
Impassable dry weather roads	9	3.8
High cess (fees)	2	0.9
Don't know	1	0.4
Total	234	100

Source: Authors' survey, 2001.

Transport constraints appear to be limiting long-distance maize trading. About 60 percent of the traders who responded to the question of the distance from farm gate to the market where they sell indicated that they sold maize within a radius of 40 kilometers (Table 13).

Poor transport network in the country not only restricts the access of households to available maize in the market, but also restricts the movement of maize by farmers or traders to market outlets owing to high transportation costs. It therefore hinders the efficient movement of maize under a free market regime. Efficient road networks should facilitate free and efficient movement of maize from surplus to deficit areas. Alderman and Shively (1996) note that in Ghana, there is room to reduce transport costs with public investments in improved infrastructure. Other researchers have emphasized the central importance of physical infrastructure, especially the network of rural feeder roads (Shaffer et al. 1985; Jayne et al. 1997; Gabre-Madhin 1998; Jones 1998; and Fafchamps 1999). A good infrastructure eases frictions in shipments between surplus and deficit areas, while an inefficient one impedes the rational marketing of commodities.

Table 12--Transport problems by different type of traders

Type of trader	Problem	% of traders
Wholesaler (open air)	High transport costs	23.8
Retailer (open air)	Poorly maintained roads	29.5
Lorry traders	Poorly maintained roads	40.0
Transporters	Poorly maintained roads, high transport costs, insecurity	20.0
Wholesalers (store)	High transport costs	30.4
Large-scale millers	Poorly maintained roads	20.0
Bicycle traders	Poor rural access roads	33.3
Posho millers	Poorly maintained roads	23.1
NCPB	Poor rural access roads	50.0

Source: Authors' survey, 2001.

Table 13--Reported distances from the farm gate to the market by district

Distance in km	Number of traders responding by district					
	Mbeere	Nairobi	Trans Nzoia	Migori	Total	%
0–40	46	5	44	46	141	60.3
41–80	1	2	6	8	17	7.3
81–120	1	2	0	2	5	2.1
121–160	2	1	0	0	3	1.3
161–200	0	1	0	1	2	0.9
201–240	0	2	0	0	2	0.9
241–280	0	0	0	0	0	0.0
281–320	0	1	0	0	1	0.4
321–360	0	3	0	0	3	1.3
361–400	0	0	0	0	0	0.0
401–440	0	3	0	0	3	1.3
441–480	0	2	0	0	2	0.9
481–520	1	1	0	0	2	0.9
No response	9	37	4	3	53	22.6
Total	60	60	54	60	234	100

Source: Authors' survey, 2001.

3.3.2 Storage Facilities

This study seeks to establish the reasons why traders store maize, where they store their maize, and the storage problems that they face.

In the maize-surplus districts the storage function is meant to assemble maize into large quantities (bulk building), whereas in the maize-deficit districts traders store maize for bulk breaking. Traders interviewed revealed that the main aim of storage is to stock maize in anticipation of price increases (Table 14).

Table 14--Main reasons given by traders for storing maize

Reason	Number of traders reporting reason	%

Overcome period of low prices	113	57.4
Assemble large quantities (bulk building)	41	20.8
Ensure continuous supply	21	10.7
Disassemble into smaller quantities (bulk breaking)	18	9.1
Lack of transport	4	2.5
Total	197	100

Source: Authors' survey, 2001.

According to the field survey results, about 29 percent of the sampled traders store their maize in hired stores and godowns, while some do so either in their own houses (24 percent) or in their own stores and godowns (22 percent). Storage in stalls in marketplaces and in open-air markets is relatively unimportant because of levies charged by the local authorities and associated risks especially theft of the stored stocks. Very few farmers and traders have invested in storage facilities. The NCPB depots are also relatively unimportant in providing storage to private traders. This situation can be attributed to the high rent charged and the bureaucracy involved in acquiring storage space.

The major maize storage problems as reported in the sampled districts are shown in Table 15. Lack of capital and credit, erratic price changes, problems of pest infestation (mainly rodents and weevils), and high storage costs were cited as the major obstacles that limit the capacity to store maize (Figure 6). Insect pests are the most severe and widespread biological constraints on grain storage, and traders complained about the inefficacy of the pesticides they use.

In order to increase their capacity to store maize, the sampled traders were of the opinion that provision of capital in the form of soft loans, increased trader bargaining power (to counter monopsonistic tendencies by large traders and processors), and reduced storage charges were necessary. In addition, farmers' adherence to the NCPB's recommended moisture levels and the provision of affordable and high-quality pesticides would enhance traders' capacity to store maize.

Table 15--Reported maize storage problems by district

Problem	Number of traders reporting problem in:				
	Mbeere	Nairobi	Trans Nzoia	Migori	Total
Rodents and other pests	28	19	35	36	118
Theft/insecurity	2	10	6	3	21
Rain damage	1	2	3	0	6
Lack of storage	9	0	4	0	13
High storage costs	4	0	0	0	4

Source: Authors' survey, 2001.

The traders also noted that provision of security and appropriate storage facilities, including the opening up of NCPB storage facilities to both the large- and small-scale traders, could help alleviate the storage problem.

The storage function of marketing under liberalization in Kenya should contribute to price stabilization and long-range food security mainly by facilitating private sector involvement in marketing. This study shows, however, that traders do not have the financial and managerial capability to store maize and be able to exploit seasonal price changes. A similar observation has been made for Ghana by Badiane and Shively (1998), who have suggested improvements in local storage to reduce food price variability.

Improving grain storage requires investments in physical facilities, research, and extension for on-farm and off-farm storage as advocated by Tyler and Bennett (1993), improvement of credit access by farmers and traders, and reduction in market risk occasioned by policy reversals.

3.3.3 Market Centers and Marketing Facilities

The existence of accessible market centers and adequate marketing facilities is a necessary prerequisite for the development and acceleration of private trade. About 95 percent of the sample respondents reported that between one and six markets exist near the locations where they operate. About 48 percent of the respondents reported that these marketplaces are easily accessible, whereas about 52 percent felt otherwise. About 48 percent of the respondents said that these market centers have the necessary facilities for maize trading, whereas about 52 percent said that these marketing facilities are inadequate (Table 16).

Market centers are administered and run by the local governments, who are also supposed to provide and maintain the market facilities. The traders in turn pay a market fee to the local council. This fee varies from council to council depending on the market facilities provided, but it is usually about KSh. 10 per 90 kg bag of maize. Apart from the market fee, those traders who rent stalls also pay a monthly rent fee and security fee.

Table 16--Responses on availability of marketing facilities

District	Number of traders who believe that marketing facilities:	
	Are adequate	Are not adequate
Nairobi	48	7
Mbeere	21	34
Trans Nzoia	19	22
Migori	15	45

Source: Authors' survey, 2001.

We were surprised by the high level of satisfaction among the respondents with the market facilities, as the market centers lacked several appropriate marketing facilities. Most of them are periodic open-air markets with no stalls, sanitation, or drainage. Some do not even have a perimeter fence. They are usually muddy or flooded during the rainy season and dusty during the dry season. Most of the facilities were in a dilapidated state. Local council officials cited limited resources, inefficient council administration, and inadequate technical capacity as the reasons for lack of maintenance.

Approximately 37 percent of the interviewed traders wanted the markets improved through provision of water, sanitation, and proper drainage. A further 29 percent believed that stalls should be provided as a way of improving the markets, whereas 4 percent wanted security to be improved. We also formed the opinion that provision of roofs over the facilities would go a long way toward improving the marketing conditions.

The existence of hygienic and secure market centers and marketing facilities is important not only to increase participation in private trade, but also to increase efficiency in handling activities. Improvement of market structures and facilities is an immediate measure that would greatly support the development of private maize trading.

3.3.4 Availability of Market Information

The possibilities for flow of market information in Kenya are mainly through print media, electronic media, and personal contacts or telephone. The Market Information Branch of the Ministry of Agriculture also publishes wholesale market prices for more than 20 major food commodities in the major towns of the country five times a week. Of the 160 traders who responded to the question of availability of information on prices and supply, 48 percent reported that they obtained information by visiting marketplaces, 27 percent through other traders, 15 percent through brokers, 4 percent from friends and relatives, 3 percent from NCPB officials, and 2 percent through print and electronic media. This result suggests the existence of an underdeveloped market information system and the ineffectiveness of the Market Information Branch of Ministry of Agriculture in supplying information.

Surprisingly, about 79 percent of the traders reported that the market information that they receive is adequate for decisionmaking, whereas 21 percent said that it was not. On the issue of whether market information availability and flow has improved since implementation of the liberalization policies, 76 percent of the respondents said that the situation was now better, 15 percent said that it had worsened, and 9 percent could not tell whether market information and flow had improved or not (Table 17). This result, while contradicting the observation of underdeveloped information system, suggests that traders have become accustomed to poor market information and high transaction costs, which they factor in their pricing behavior.

Table 17--Traders' perception of the availability of market information by district

District	Number of traders reporting that:		
	Availability of market information is better since liberalization	Availability of market information is worse since liberalization	They cannot tell whether it is better or worse
Migori	58	2	0
Mbeere	45	1	6
Trans Nzoia	35	19	0
Nairobi	31	13	12

Source: Authors' survey, 2001.

The traders suggested that measures such as formation of a maize traders organization, accurate and reliable market information relayed through the print and electronic media, and provision of up-to-date market information by the Ministry of Agriculture through the market information bulletins would go a long way toward improving the flow of market information.

Limited public market information results in asymmetric information and is one of the institutional issues affecting efficiency of markets in Africa (Dorward, Kydd, and Poulton 1998; Gabre-Madhin 1998; Fafchamps 1999; Jayne et al. 1997). Provision of market information is an area in which the state can play a key role in improving market efficiency and general economic development.

3.3.5 Availability of Credit

This study establishes that there are few opportunities for maize traders to receive credit, from either banks or other sources. As shown in Figure 7, most traders obtained initial capital to enter the maize trade from other businesses and from agricultural activities.

Of the 22 traders who responded to the question about the source of credit, 32 percent obtained it from commercial banks, 27 percent from cooperative societies, 9 percent from fellow maize traders, 14 percent from informal moneylenders, and 18 percent from relatives. The study shows that few wealthy traders extend credit to maize farmers or to other traders and regular customers on mutual agreement. There was no evidence of an established well-functioning informal credit system. More than 82 percent of the traders interviewed said they do not get adequate credit. Any cash credit obtained is mostly from relatives or other traders. Formal bank credit to traders is very rare mainly because of high interest rates and collateral requirement.

Forty-six percent of the interviewed traders, however, reported that availability of credit is better now than in the preliberalization era, 32 percent said that credit availability had worsened, and 22 percent were not sure. As shown in Figure 8, the traders cited high interest rates, short or no grace period in loan repayment, and the collateral requirement as the major problems experienced in acquiring credit. The interviewed traders made a number of suggestions on how the problem of credit can be solved: 38 percent cited reduction of interest rates, 31 percent wanted to be given an adequate grace period, 18 percent wanted more loan schemes to be formed, and 13 percent argued that with removal of loan security demands (guarantors and collateral requirements) credit problems could easily be solved.

Lack of capital and credit hampers the entry and expansion of private trade. It affects transport operations, storage capacity, and the general efficiency of the entire maize marketing system. As Jones (1998) has observed, the limited capacity of the small-scale private sector to deepen and expand its operations beyond small-scale processing and assembly, wholesale, and retail activities points to the need for effective systems of credit and input supply, as well as market regulation to promote supply of public goods such as information and contracts. This is a key policy issue that has emerged across a wide range of countries. Credit, therefore, is a critical area of public support. The state must take into consideration the particular needs facing the large number of small-scale private sector participants by, for instance, designing group lending schemes.

3.3.6: Government Policy

This section considers the role of the government in facilitating private maize trade, the role of the NCPB in a liberalized market, and the problems associated with actions of government that traders have been facing in the liberalized maize market.

Apart from the itinerant open-air maize traders who pay a market fee to the local authorities, maize traders and processors are required by law to have a trading license. The fee paid to acquire a trading license varies depending on the scale of business. Small-scale traders pay a license fee of approximately KSh. 500 per year, whereas the large-scale maize traders and processors pay more than KSh. 10,000 every year. Traders perceive the trading license requirement as an impediment to entry and expansion in the maize trade. Many small traders consider licenses costly and difficult to obtain owing to opaque requirements. Not only must traders go through a cumbersome bureaucracy, but also often have to bribe officials in order to acquire the license. The licensing procedure needs to be simplified and requirements publicized to ease the licensing process.

3.3.6.1 Traders Perception of the New Role of NCPB

Before the reforms in the cereals sector, the bulk of the marketed maize surplus in Kenya went to the NCPB. This study seeks to determine whether the private traders understand the role of the NCPB under the new marketing arrangement. About 78 percent of the sampled private traders said that they know the role of NCPB in the post-liberalization era. Of the 176 respondents on the question “What are the roles of NCPB in maize marketing?” about 55 percent said that under liberalization it is supposed to act as a buyer and seller of last resort, and about 45 percent saw it as a body that is supposed to maintain strategic maize reserves. On the question of whether the private traders find the NCPB an impediment to their participation in maize trade, 70 percent did not see it as an impediment, 24 percent saw it as an impediment, and 6 percent reserved their comments. Those who saw the NCPB as an impediment to their maize trade argued that the NCPB does not pay promptly for maize delivered. Also its requirement that maize of high quality be properly dried with a moisture content of less than 13 percent is perceived as very stringent.

We also asked traders how famine relief maize, given out by the government and other food relief agencies, affects their maize trade. Seventy-two percent of the sampled respondents reported no effect, whereas 28 percent talked of some negative effects , such as increased cheap supply that depressed prices. In some instances the relief maize is clandestinely diverted to the market, once again maize prices to decline. Relief procurement procedures should be restructured to give farmers the opportunity to sell surplus to the relief agencies for subsequent delivery to deserving areas when needed.

3.3.6.2 Awareness of the Liberalization Policy

This study further seeks to investigate what traders know about the liberalized maize market. About 89 percent of the respondents said they were aware that the maize market had been fully liberalized, whereas 11 percent were not aware. This awareness by sampled districts is shown in Table 18.

Table 18--Traders' awareness of the liberalization of the maize market

District	Traders reporting they are aware of liberalization		Traders reporting they are not aware of liberalization	
	Number	%	Number	%
Trans Nzoia	52	96	2	4
Mbeere	55	93	5	7
Nairobi	52	86	8	14
Migori	48	80	12	20
Total	207	88.5	27	11.5

Source: Authors' survey, 2001.

As the table shows, awareness of maize market liberalization is highest in Trans Nzoia (the major maize-producing district) and lowest in Migori (a minor maize-producing district). Of the 207 traders who responded to the question whether the liberalization policy is good or bad, 86 percent said that the policy is good and 14 percent said that it is bad. Those in support of the liberalization policy said that the free market enables them to move maize with few hurdles and that maize from farmers has become very cheap. Liberalization has enabled surpluses to find markets far and wide. In addition, many traders have entered the market, thereby alleviating the problem of unemployment. Farm inputs, especially fertilizers, have also become readily available, and there is healthy and stiff competition among the traders. Those that did not favor the liberalization policy reported that market conditions were unpredictable, making business decisionmaking difficult. They were particularly unhappy with the high price fluctuations that have been engendered by the policy.

About 60 percent of the traders who responded to the question of government commitment to liberalization (n = 198) believed that the government is committed to the liberalization policy, whereas about 40 percent said that the government is not (Table 19).

Table 19--Traders' assessment of government commitment to liberalization policy

District	Traders who believe the government is committed to liberalization		Traders who believe the government is not committed to liberalization	
	Number	%	Number	%
Migori	44	88	4	8
Trans Nzoia	45	85	7	13
Nairobi	21	36	37	64
Mbeere	9	22	31	76
Total	119	60.1	79	39.9

Source: Authors' survey, 2001.

As Table 19 shows, traders in the surplus districts (Trans Nzoia and Migori) have the perception that the government is committed to the liberalization policy while traders in the deficit districts (Mbeere and Nairobi) are a bit skeptical of the government's commitment.

A majority of the traders were aware that they do not need a movement permit to move maize from one district to another. They were also aware that they can sell maize anywhere in the country and not necessarily to the NCPB and that they can import maize into the country subject to payment of a variable duty.

However, as shown in Figure 9, traders have faced myriad problems since liberalization of the maize trade. The major problems cited include low maize prices, lack of market, uncertain government policy, and competition from other traders and processors.

The traders suggested a number of measures that can be implemented to alleviate these problems. As Table 20 shows, solutions include enhancement of trader bargaining power, provision of soft loans to traders, and a ban on importation of maize. It seems, however, that traders like some aspects of liberalization and not others. They like, for instance, the free movement of maize and prompt receipt of payments for stocks sold, but they do not like unstable prices, which are sometimes very low. This result implies that the NCPB must be empowered to play its market stabilization role more effectively. In addition there is a need to enhance the bargaining position of the small-scale farmers and traders by helping them form associations organizations and cooperatives. Government should also show greater commitment to empowering farmers and traders by maintaining law and order (security) and enforcing contracts.

3.3.6.3 Liberalization of the Maize Market and Trader Entry

The results of this study indicate the existence of all seven major categories of traders identified in section 1.2. Traders who were identified by their use of intermediate means of transport (bicycles, oxcarts, donkeys, handcarts, and head load) were found to be an important emerging category. They perform various functions in the marketing chains, including bulking at the farm level and delivering the grain to assemblers, retailers, and *posho* millers. The numbers of sampled actors in private maize trade in the four districts are shown in Table 21.

Table 20--Traders' suggestions for alleviating maize marketing problems

Measure	Number of traders suggesting measure	%
Enhance bargaining power	53	34.0
Offer soft loans to traders	39	25.0
Stop importation of maize	20	12.8
Provide stores	18	11.5
Reduce transport costs	17	10.9
Provide security	5	3.2
Maintain roads	3	2.1
Standardize weighing equipment	1	0.6
Total	156	100.0

Source: Authors' survey, 2001.

Table 21--Types of traders by district

Type	Mbeere	Nairobi	Trans Nzoia	Migori	Total	%
Wholesaler (store owner)	17	8	23	9	57	24.4

Retailer (open-air market)	21	13	7	14	55	23.5
Posho miller	2	9	11	11	33	14.1
Wholesaler (open-air market)	12	5	0	6	23	9.8
Bicycle trader	2	7	9	5	21	9.0
Transporter	3	6	4	7	20	8.5
Lorry trader	3	5	0	3	11	4.7
Large-scale miller	0	5	0	0	5	2.1
Others (such as donkeys, oxcarts)	0	0	0	3	3	1.3
NCPB depot agents	0	2	0	2	2	0.9
Total	60	60	54	60	234	100

Source: Authors' survey, 2001.

The results of the trader survey show that during peak purchase months, wholesalers buy maize mainly from the maize-surplus districts of Trans Nzoia, Malava-Lugari, Uasin Gishu, Nandi, and others and sell it in the high-demand deficit districts of Nairobi, Siaya, Kiambu, Kisumu, and the Ukambani districts of Machakos, Kitui, and Makueni. It should be noted that the large-scale maize-growing areas are in the Rift Valley Province and have one harvest season, whereas in some parts of Kenya maize is harvested twice in a year. This difference affects the dynamics of supply and demand and may be the cause of interseasonal commodity flow reversals.

In the peak harvest season, most large-scale farmers and wholesalers prefer to sell maize to the large-scale millers because of their ability to buy in large volumes and pay promptly. Traders also report that it takes less time to sell to millers than it does to sell directly to retailers. Informal interviews also revealed that wholesalers favor selling to the millers mainly because the transaction costs per unit sold are very low compared with selling to other potential buyers.

The stationary open-air market traders operate in the local periodic markets at a small scale, with stocks ranging between one and four bags. Most of these traders are women and are constrained from holding larger quantities by lack of cash. These traders bulk-break maize, and the unit of measurement is the *gorogoro* (2-kilogram tin). The going price of one *gorogoro* at the time of the survey was approximately Ksh. 20, and 40 *gorogoros* made up one 90-kilogram bag. The storage charges levied by the local market authorities provide a major disincentive for these traders to hold their stocks inside the market.

The mobile traders and transporters carry out the functions of bulk building (assembling), storing, transporting, and distributing maize. They include bicycle (*bodaboda*) traders, lorry traders, donkey traders, and handcart traders. The lorry traders who own trucks ferry maize from surplus to deficit areas, thereby functioning as wholesalers and distributors.

Some private traders rent or own stores in towns and rural shopping centers. Farmers usually deliver small quantities of maize to these stores as the need for cash arises. The turnover for such traders is in the range of 2,000-4,000 bags per year. Storage is limited to the length of time it takes to find a buyer. If no buyers are forthcoming, the store owner hires a lorry to deliver the maize for sale either to NCPB stores or to other traders in deficit areas some distance away.

Maize milling accounts for the majority of maize processing and is the most organized market for maize in the private sector. The number of millers has increased with the advent of liberalization. They range in size from large sifted-flour mills with the capacity to purchase and store maize to ordinary *posho* mills, which rarely engage in any storage. Although the NCPB operates a network of depots throughout the country, the advent of liberalization and the consequent reduction in state funding has diminished its role in the maize market. Although it is supposed to stabilize the maize market through its commercial activities, its main role today is the maintenance of strategic grain reserves and management of famine relief supplies. In recent years the operations of the NCPB have caused considerable confusion, as its future role in the grain market remains unclear.

Kenya provides an excellent case study for examining the effects of food market liberalization. Before liberalization, the NCPB was the only official buyer and seller of maize. A casual review of Table 22 reveals a substantial entry of different types of traders since liberalization. About 56 percent of the sample traders entered the maize market after 1993. Widespread postliberalization entry into food marketing is a common observation in most countries in Sub-Saharan Africa (Kherallah et al. 2002). According to the perception of the sampled traders, it appears that in Kenya the trader categories that have witnessed increased entry since liberalization include open-air retailers, open-air wholesalers, wholesalers who operate in stalls or stores, and *posho* millers.

32.6 percent of the sampled traders believe that open-air retailers have increased the most (Table 22). The numbers in this table have important implications for food market development. Massive trader entry has occurred in those market niches that do not require high initial capital investment, such as open-air retailing. The commonly cited bottlenecks of lack of interseasonal storage and motorized transport identify trader categories into which there has been little postliberalization entry. This is particularly true of the long-distance maize transporters and large-scale millers, which have witnessed low trader entry even with the advent of liberalization. To use Caves and Porter's (1977) term, there are mobility barriers to movement within the maize marketing system from one niche to the next. Chief among these barriers in the Kenyan case are lack of access to working capital, market information, bulk storage and transport, and a reliable network of customers and suppliers. Together these problems pose a major challenge for food market development in Kenya and Sub-Saharan Africa.

Table 22--Traders' perceptions of trader categories that have expanded since liberalization

Trader category	Number of traders reporting this category	%
Retailers (open air)	73	31.2
Wholesalers (open air)	61	26.1
Wholesalers (stall/stores)	51	21.8
Posho millers	17	7.3
Retailer (stall/stores)	12	5.1
Lorry traders	7	3.0
Long-distance transporter	2	0.9
Large-scale miller	1	0.4
Do not know	10	4.3
Total	234	100

Source: Authors' survey, 2001.

Yet despite the problems with food market development in Kenya, market development has improved since liberalization, with 78.2 percent of the sampled traders, engaging in maize trade on a full-time basis (Table 23).

3.4 Maize Marketing Costs

Traders were asked what price they paid for maize both at the farm gate and at the wholesale levels immediately after harvest for the 2000/01 season. Prices paid at the farm gate ranged between Ksh. 400 and 1,500 per bag, whereas the wholesale prices ranged between Ksh. 600 and 1,500. For the sampled traders, the selling prices ranged between Ksh. 600 and Ksh. 1,900 per bag, but it should be noted that the market intermediaries operated at different channel levels, hence incurring different marketing costs.

Table 23--Job status of traders

Type of trader	Number of full-time traders	Number of part-time traders
Retailers (open air)	42	12
Wholesalers (open air)	20	3
Wholesalers (stall/stores)	43	14
Posho millers	25	8
Bicycle traders	17	5
Lorry traders	7	4
Long-distance transporter	17	3
Large-scale miller	5	0
Others	7	2
Total	183	51

Source: Authors' survey, 2001.

In addition to the cost of purchasing maize, traders incur other marketing costs. These include transport costs, storage costs, loading and unloading costs, license and market fees, bribes to licensing and police officers, security fees, and costs of packaging materials. Long-distance maize traders also incur boarding and lodging fees. Each of the identified cost categories presents an opportunity for a closer look at how to reduce marketing costs.

3.4.1 Transport Costs

Few of the traders interviewed own means of transport. The main reasons cited for not having their own means of transport are lack of sufficient starting capital and the high risk and costs involved in operating owned vehicles. In the rural areas intermediate means of transport (such as donkeys and bicycles) are important in transporting maize from the farms to the nearest marketplaces. Traders pay approximately Ksh.4.40 on average to transport one bag of maize per kilometer on all-weather roads, compared with Ksh.7.60 on dry-weather roads. There is thus a need to improve roads from dry- to all-weather in order to reduce maize transport costs, thereby raising producer prices and lowering prices to consumers.

3.4.2 Storage Costs

Survey results reveal that the majority of the traders (about 78 percent) store maize for a period of 1-4 months. On average, storage costs were estimated to be about Ksh. 30 per bag per month, equivalent to between 2 and 7.5 percent of the farm gate price. Traders usually maintain a rapid turnover because of lack of storage facilities, high risks of produce theft and quality deterioration, together with uncertainty regarding government policy, fluctuations in selling prices, high costs of pesticides, and inadequate working capital to finance stockholding. The strict conditions and quality standards set by the NCPB also act as a further disincentive. Some of the conditions set by the board include limiting the moisture content to less than 13 percent and requiring an upper limit of not more than 1 percent foreign matter, 1 percent broken matter, and 2 percent rotten, diseased, and discolored grains. Alleviating storage constraints could reduce storage costs and enhance temporal arbitrage.

3.4.3 Loading and Offloading Costs

Average loading costs at the various maize markets were very similar, ranging between Ksh. 8 and 12 per 90 kg bag. Modal loading costs in each market were Ksh. 10 per bag, but a few small-scale traders were paying below-average rates as low as Ksh. 5 per bag. Loading and offloading was by human labor, and little mechanization was observed.

3.4.4 License and Market Fees

According to the commercial law of Kenya, all traders are required to obtain a trading license. Depending on the volume of trade, the fee paid ranges from Ksh. 500 per year for very small-scale traders to Ksh. 100,000 per year for very large-scale maize millers and processors. Marketplaces administered by the local governments normally charge a daily flat rate market entrance fee. This fee ranges between Kshs. 10 and 20 depending on the respective local government rates.

3.4.5 Bribes

In December 1993 virtually all restrictions on interregional maize trade were lifted, but police roadblocks remained. Traders still need to obtain a trading license, but this requirement has been loosely enforced, and most traders continue to operate without trading licenses. During the field survey for this study, the study team interviewed 13 traders who admitted having paid bribes to police officers. These bribes ranged from Ksh. 500 to 3,600. The bribe depends on the number of bags being transported. Other traders also reported having paid bribes to licensing officers. Bribes to licensing officers ranged from Kshs.100 to 3,000. The existence of this rent-seeking behavior points to cumbersome licensing procedures and unclear requirements. Enforcing zero tolerance of corruption will guarantee elimination of this marketing cost.

3.4.6 Other Marketing Costs

Maize traders also incur costs of packaging materials (usually jute and polypropylene gunny bags), which normally cost between Ksh. 20 and 30 per bag. Security fees and boarding and lodging fees are additional costs incurred, especially by long-distance maize traders. Boarding and lodging costs could be reduced through improved market transparency and contract enforcement laws that would allow for flow of products without the need for physical inspection.

4.0 CONCLUSIONS AND POLICY RECOMMENDATIONS

4.1 Conclusions

The major objective of this study was to analyze the efficiency of the maize marketing system and determine how its efficiency has been affected by liberalization. To this end, we carried out an analysis of market integration among spatially separated markets, both in the pre- and postliberalization eras, using a number of techniques. An important goal of market liberalization and the opening of maize markets to private traders was to increase market efficiency by reducing marketing costs and spatial and temporal price differentials. We investigated this issue by considering changes in price spreads and volatility and the level of marketing costs. Finally we considered the effect of infrastructure and government actions on market efficiency.

The results show that the liberalization policy has enhanced market efficiency as measured through market integration and that there are potential opportunities for arbitrage between maize surplus and deficit regions. Liberalization has also led to the development of central markets (Nairobi in the consumption zone and Kitale in the production zone), indicating movement toward a more organized marketing system.

The arbitrage opportunities brought about by liberalization will, however, remain largely unexploited because of infrastructural, institutional, and policy constraints that hinder the development of a private sector that could perform the functions hitherto performed by government agencies. These constraints include:

- Transport constraints (poor road network, high transport costs, and poorly maintained roads);
- Storage constraints (lack of storage capacity, high storage costs, and lack of appropriate storage technologies);
- Inaccessible market centers and inadequate marketing facilities in the market centers;
- Lack of accurate and reliable market information;
- Lack of capital and access to credit;
- Unclear and uncertain government policy;
- Insecurity; and
- Nonenforcement of contracts, grades, and standards.

Poor infrastructure raises marketing costs; licensing requirements hinder entry into maize trade; unavailability of credit limits traders' access to working and investment capital; while unclear and unreliable government policy creates unwarranted uncertainty in the maize subsector.

4.2 Policy Recommendations

The following policy recommendations are drawn from the results of this study:

Reduce transport costs: The government must take positive steps to overcome high transport costs. Long-term policies should focus on investing in transport infrastructure. Systems should be developed to lease transport facilities (such as trucks, etc) to farmers and farmers' associations (to be encouraged) and rural traders to move maize from remote areas to local markets and assembly points. Medium- and long-term investment loans for the purchase of means of transport should be made available to traders.

1. **Increase storage capacity**: In the short term the storage capacity owned by the NCPB should be leased to the private sector under favorable terms. In the long term investment in on-farm and off-farm storage facilities by the private sector should be encouraged and supported. Another important area of government support in maize storage is research and extension in post harvest technology to help traders avoid storage losses as well as to ensure the sale of maize when the prices guarantee profitable operations.

2. **Improve market facilities**: Wholesale maize marketing sites should be developed at major regional nodes, and market facilities and assembly points should be created in the rural areas near the major transport routes. Local governments should supply adequate marketplaces and marketing facilities as a service, by using revenues from fees usually collected from the traders.

3. **Provide accurate and reliable market information**: Accurate information on price, supply, and demand situations needs to be collected from the emerging central markets and relayed to market participants in a timely fashion. The Agricultural Information Service of the Ministry of Agriculture should receive adequate budgetary allocation to allow it to perform this role. The Ministry of Agriculture and farmer organizations could provide long-term outlook information. Availability and improvement in communications infrastructure, especially in the rural areas, should receive more attention from the government.

4. **Increase access to credit**: Government should encourage the development of nonbank institutions (including traders' and farmers' organizations) with expertise in lending to farmers and agribusiness, which more conventional lending institutions find too risky. Lending by financial institutions to small-scale traders and farmers could be encouraged by government underwriting of such credit schemes.

5.**Develop farmers' and traders' organizations**: This needs special attention as the results of this study clearly indicated the traders' felt need for such organizations. The organizations would enhance farmers' and small traders' capacity to exploit economies of scale in acquiring marketing inputs, access to credit, and capacity to negotiate for better prices with the more organized large buyers, who often possess more market information. The government and nongovernmental organizations have a clear role to play in catalyzing the formation of functional farmers' and traders' organizations.

6**. Enact stable, unambiguous, and supportive government policy**: Until now the Kenyan government has limited itself to a passive role by merely allowing private trade to exist. An articulate and stable government food policy to support the development of the private sector is needed. Government must have clear objectives for the private sector in the liberalized market. Private traders need assurance that their legal status is not under any threat and that they will retain their current freedom to move maize and take other marketing actions. Policy reversals that create uncertainty in the market should be avoided. The rapid changes introduced into the marketing sector in recent years should be embedded in effective legislation. Enforcing contracts and standards regulations are key to establishing an enabling environment for liberalization to yield positive benefits to traders and other market participants.

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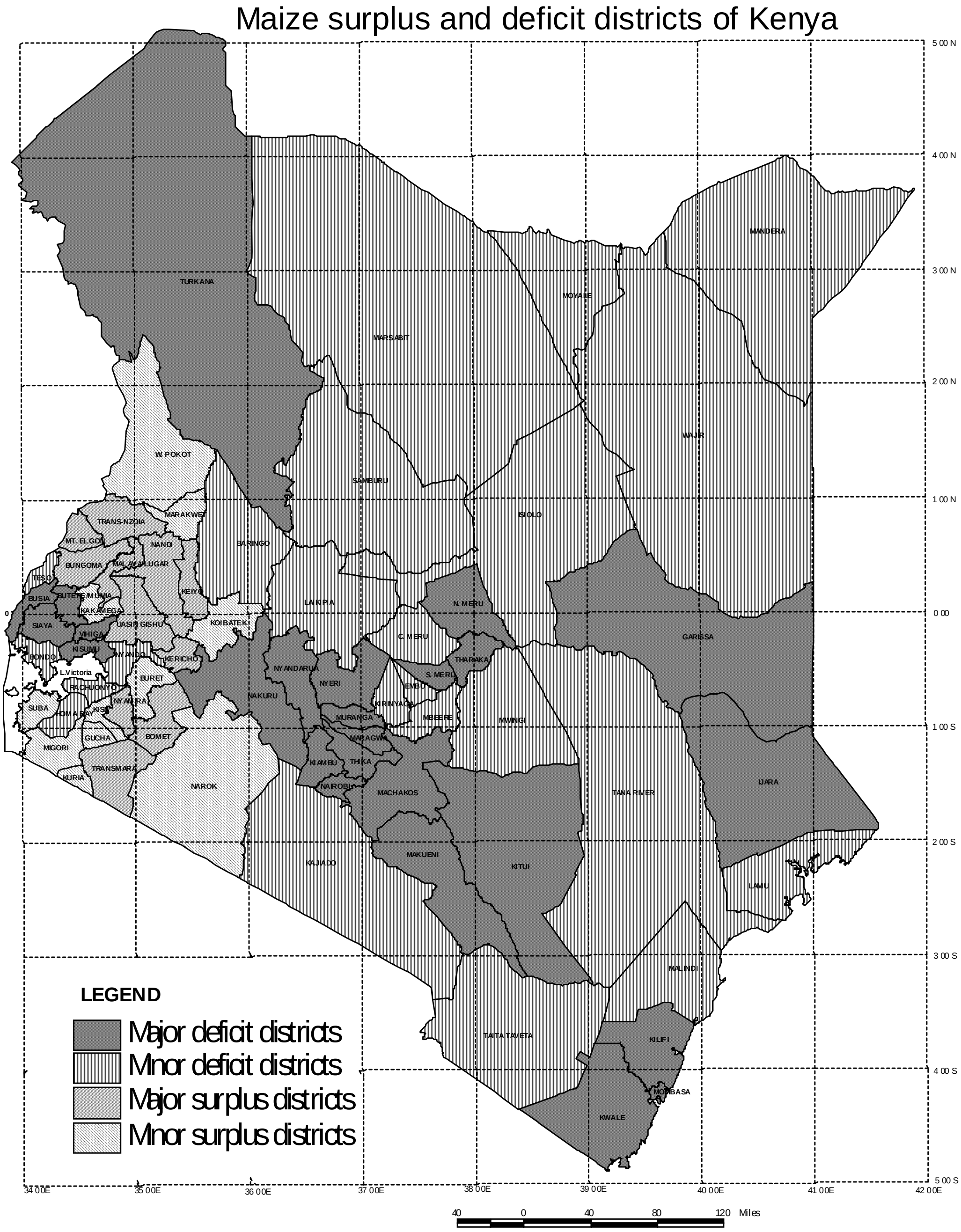
Figure 1 Maize surplus and deficit districts of Kenya



Source: GIS analysis, 2001

Figure 2 The maize marketing system in Kenya

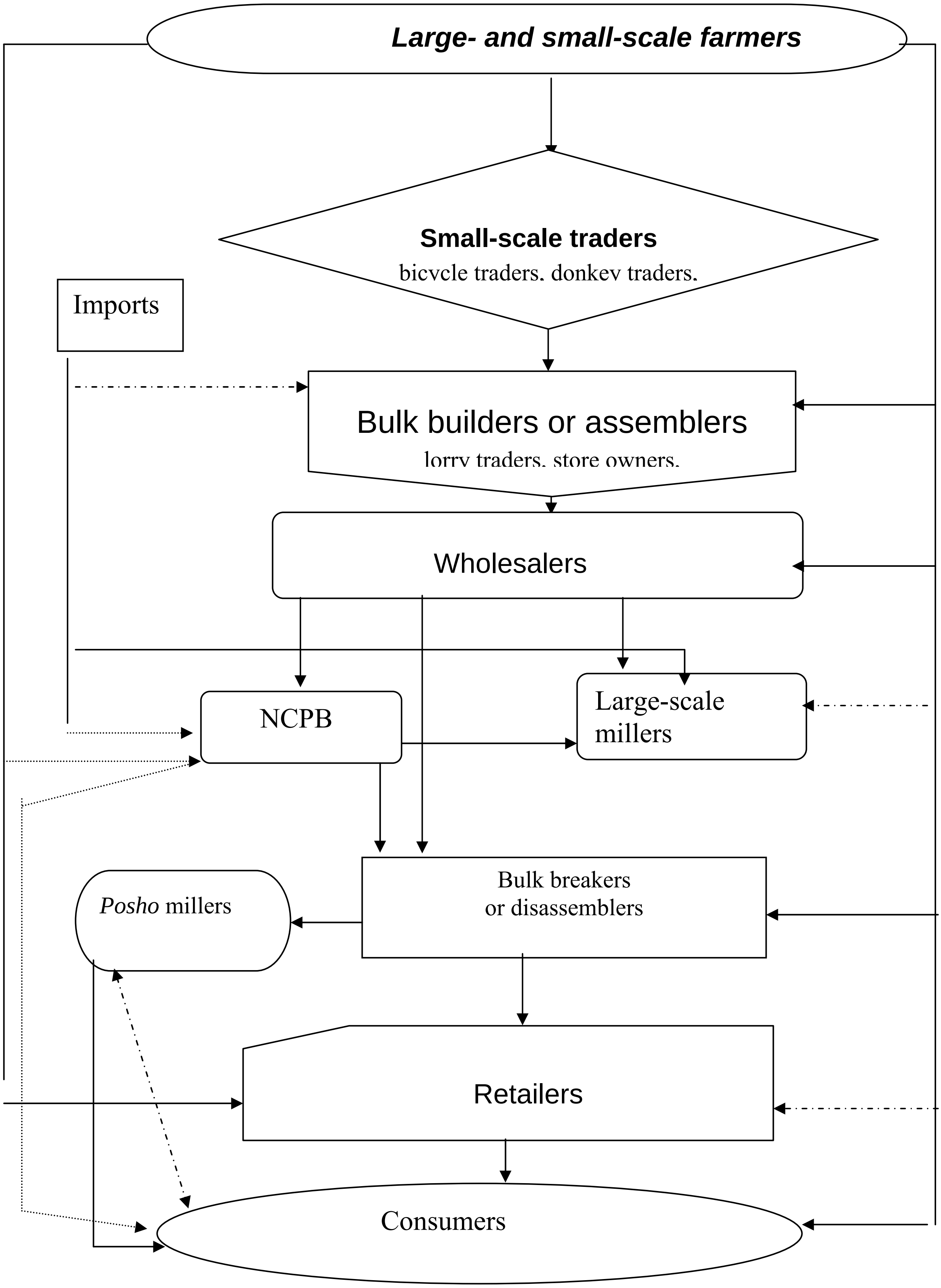
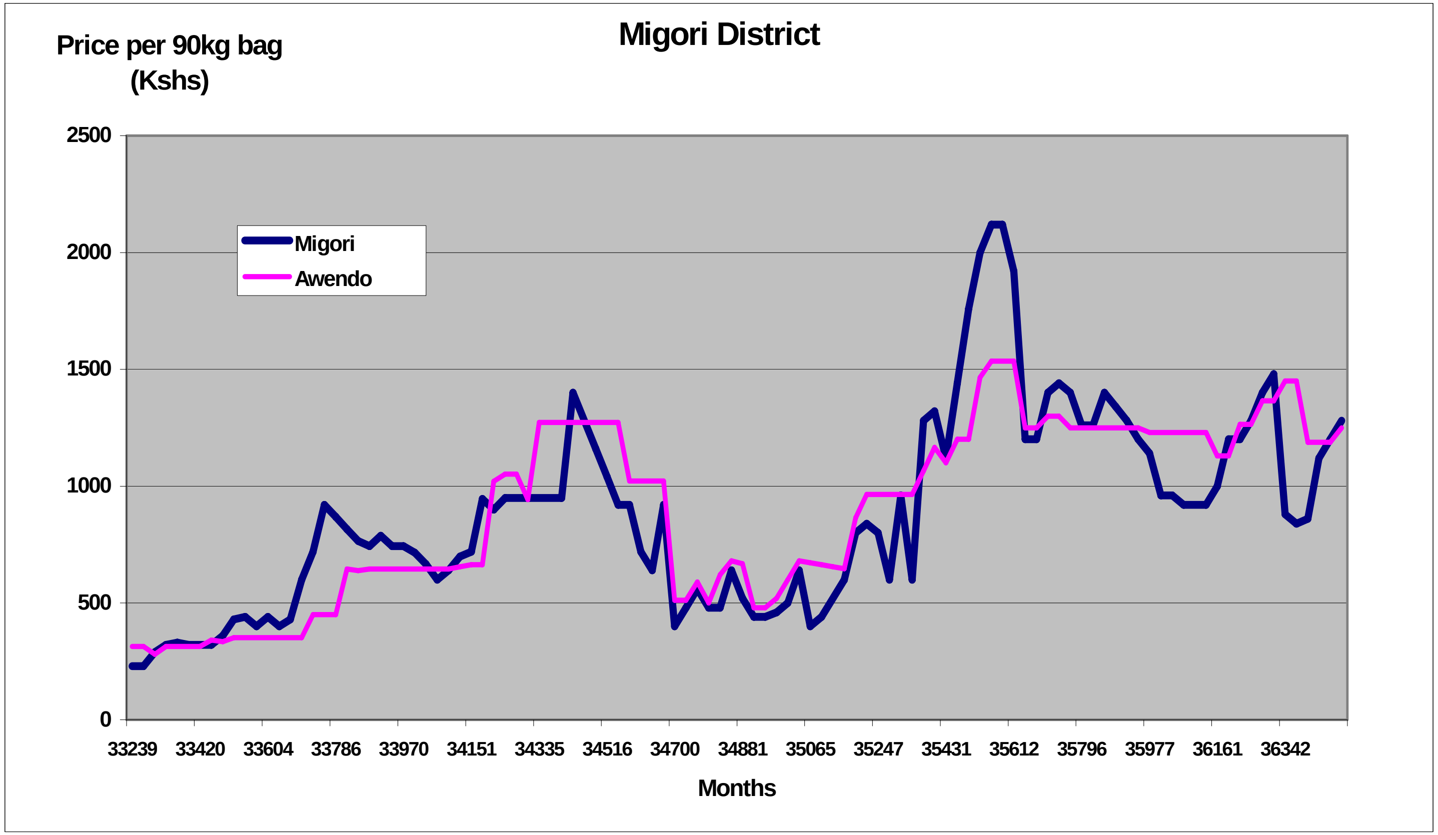
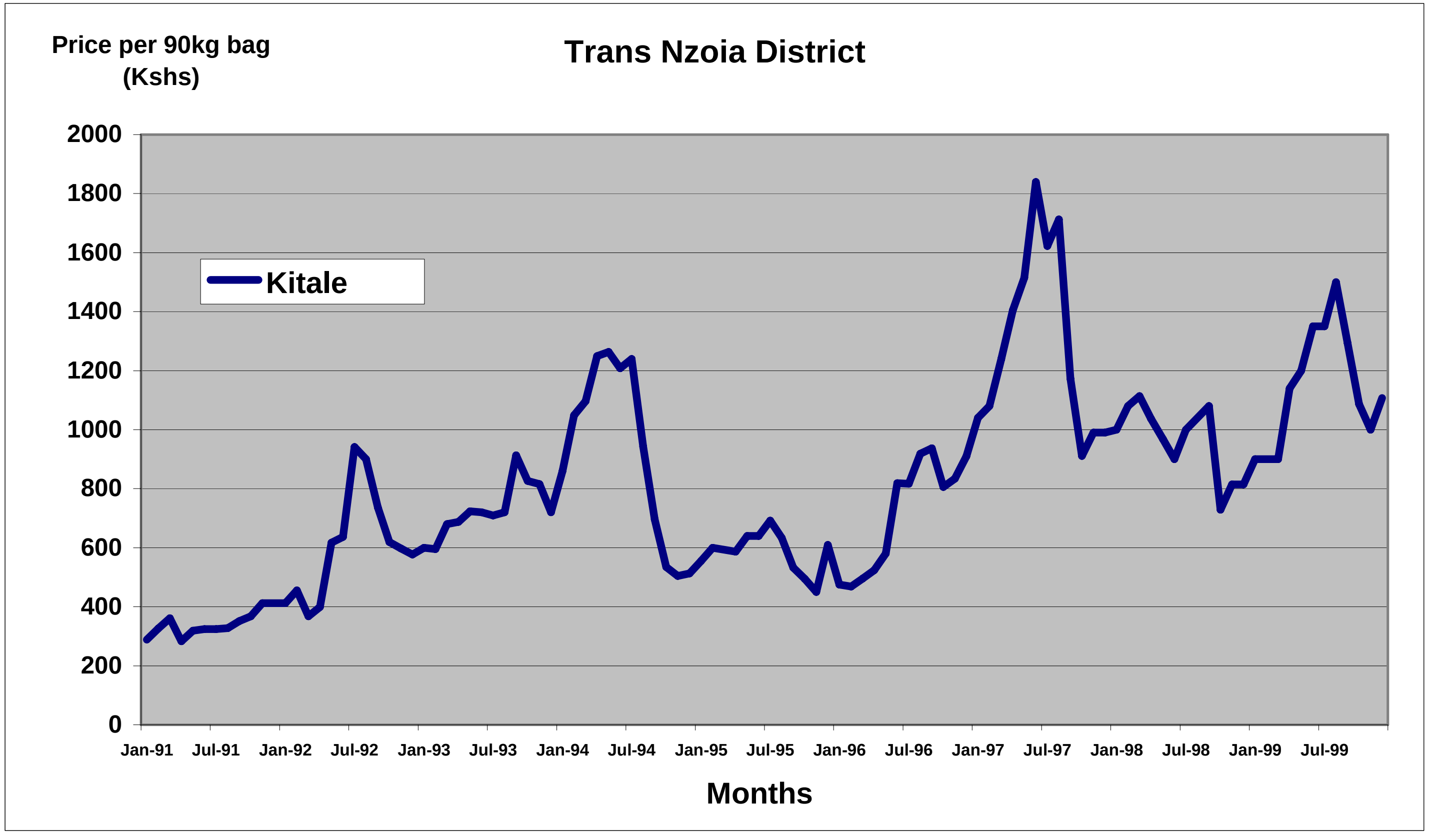


Figure 3 Trends in Maize Prices 1991-99




Price per 90kg bag (Kshs)
Trans Nzoia District
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Kitale
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
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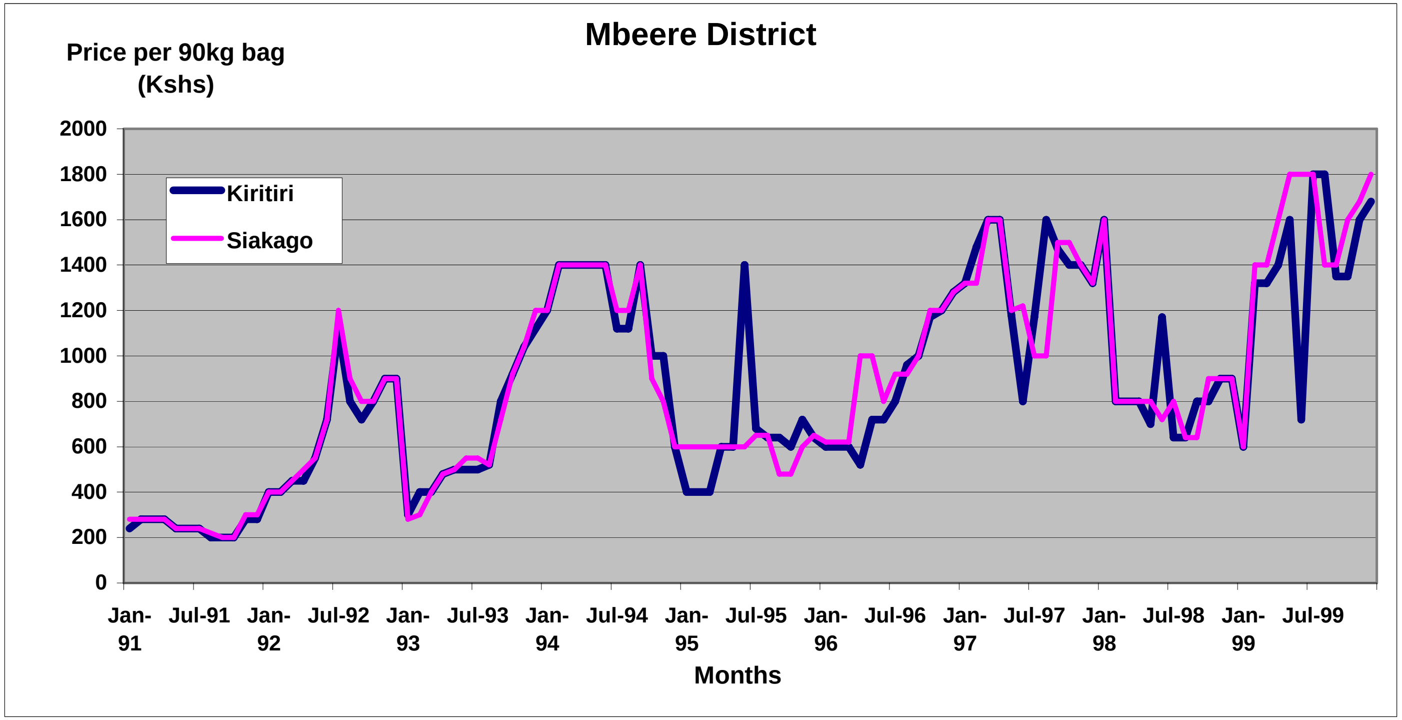
Jan-99
Jul-99
Months



Mbeere District
Price per 90kg bag (Kshs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Kiritiri
Siakago
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
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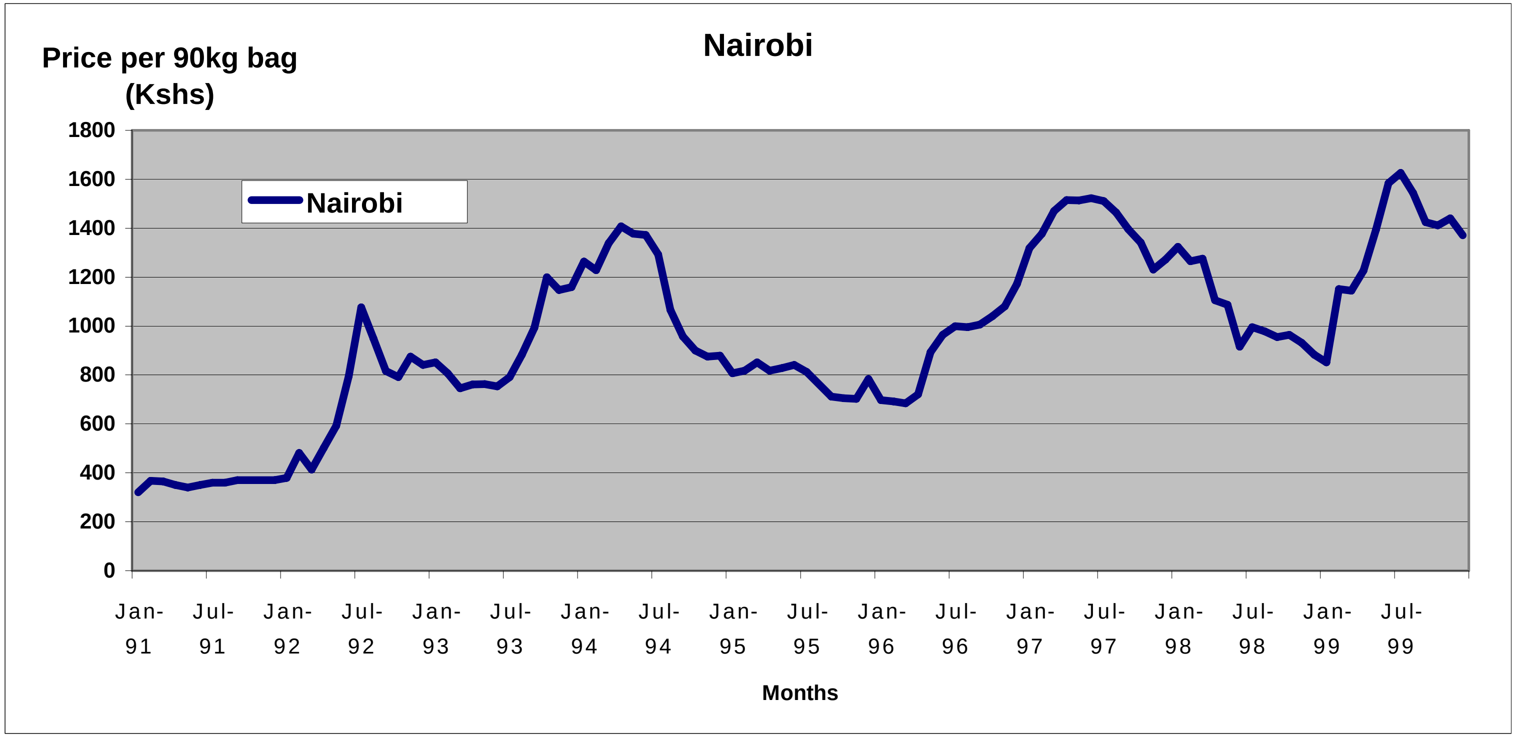
Jan-98
Jul-98
Jan-99
Jul-99
Months



Nairobi
Price per 90kg bag (Kshs)
1800
1600
1400
1200
1000
800
600
400
200
0
Nairobi
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
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Jan-97
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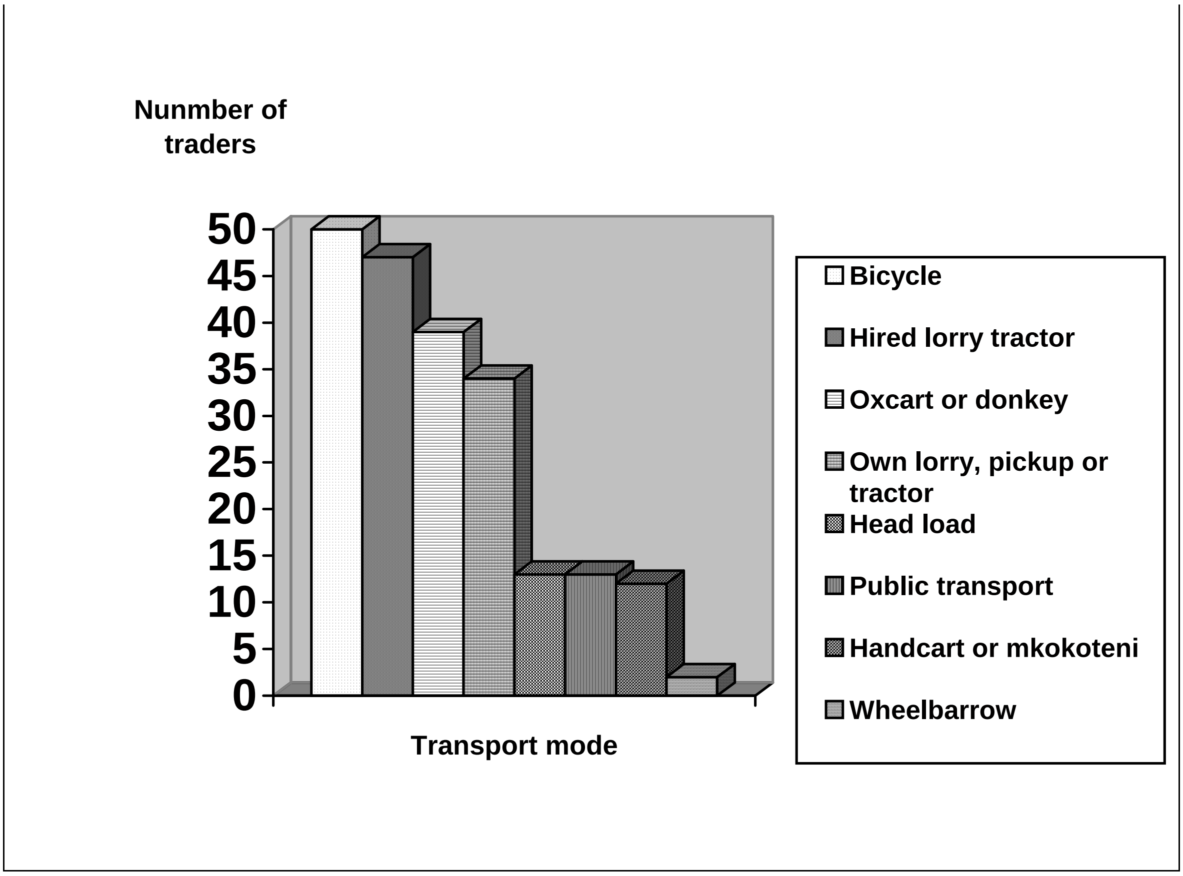
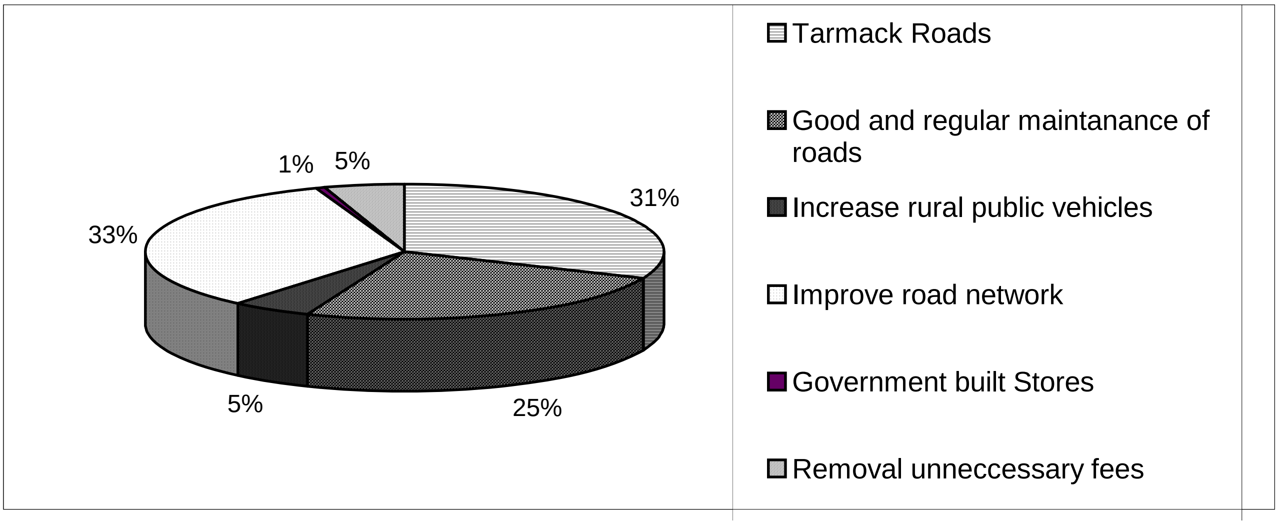
Jul-99
Months

Figure 4 Modes of transporting maize



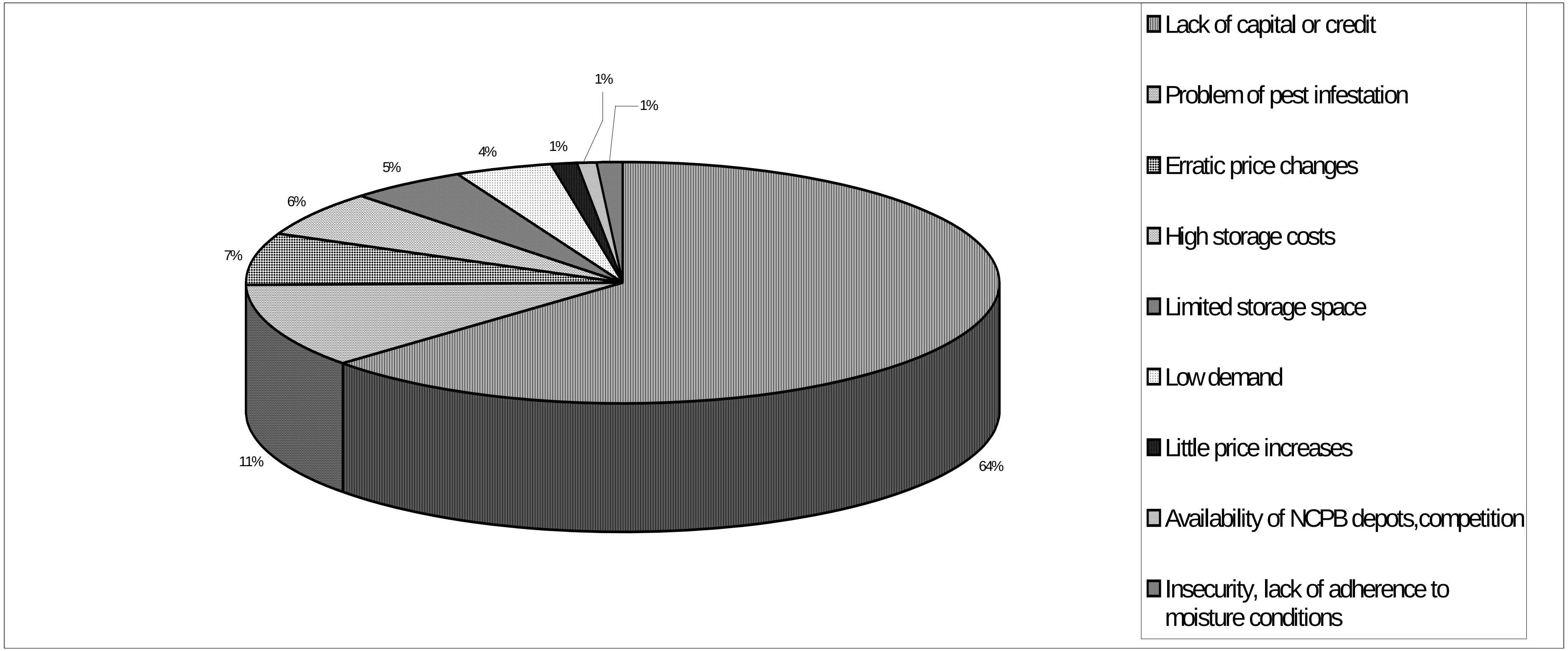
Source: Authors' Survey, 2001.

Figure 5 Solutions to transport problems as suggested by traders



Source: Authors' survey, 2001.

Figure 6: Limitations to storage capacity as reported by sampled traders



Source: Authors' survey, 2001

Figure 7 Sources of initial capital to enter maize trade

Source: Authors' survey, 2001

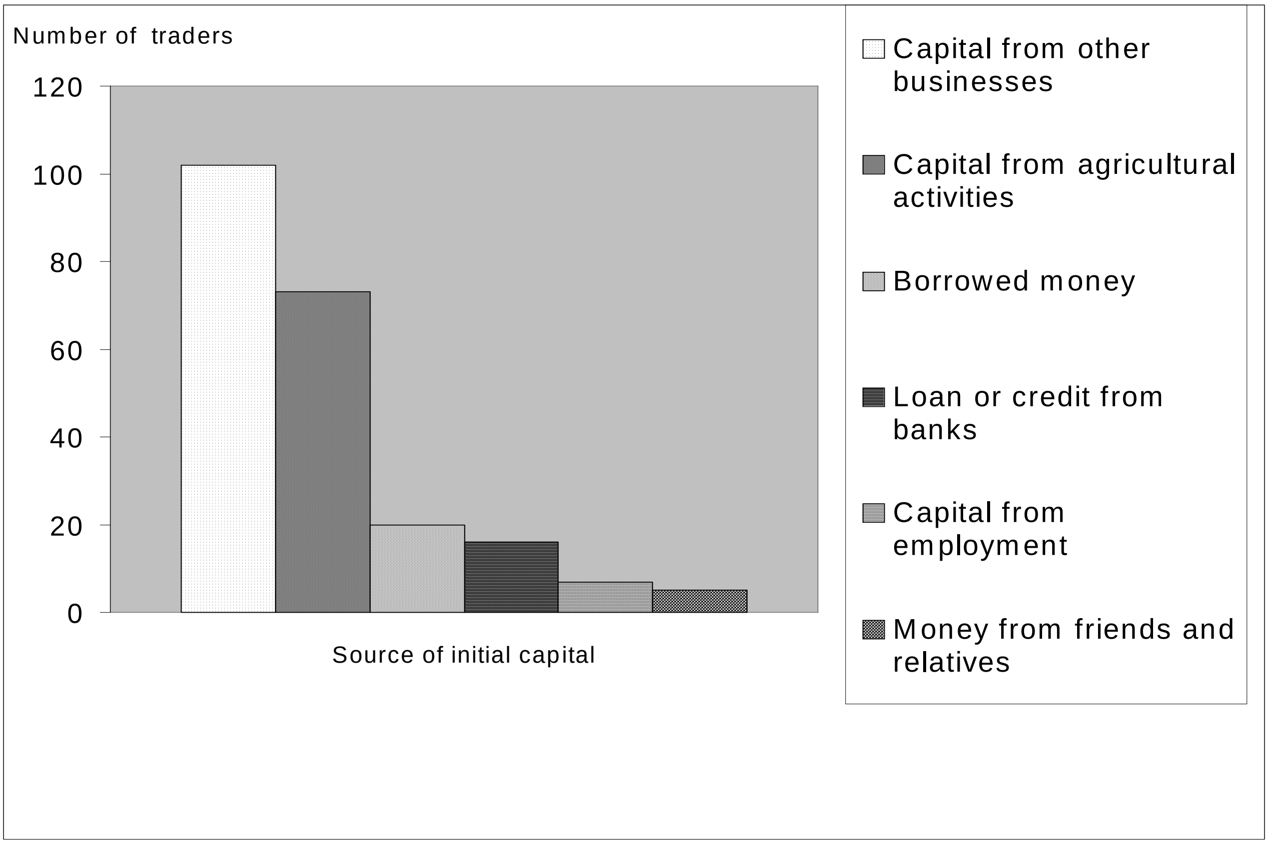
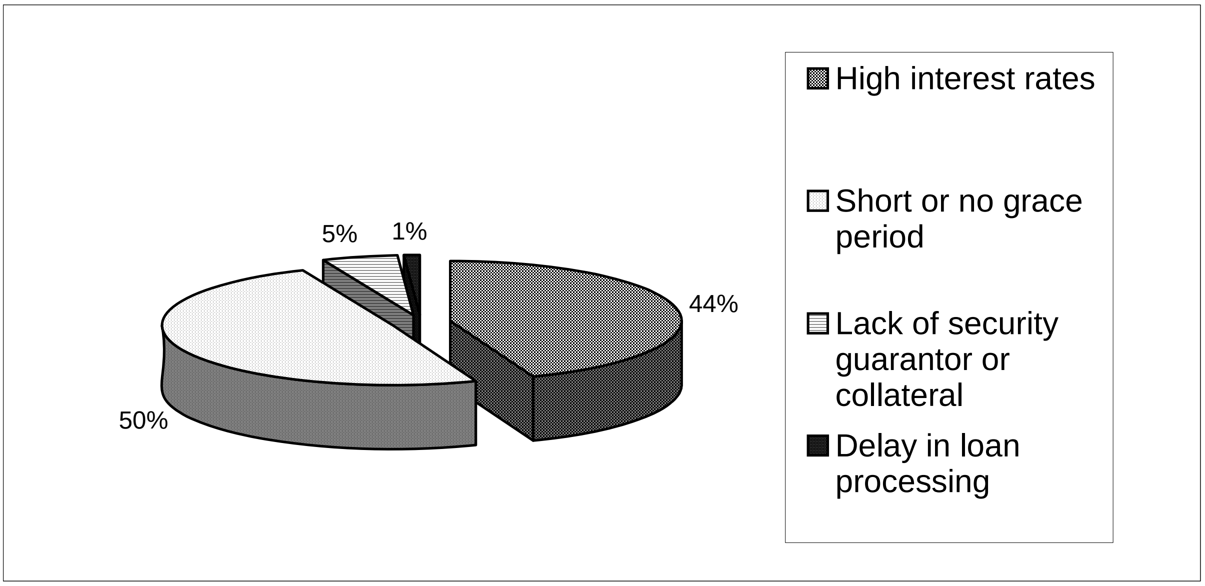
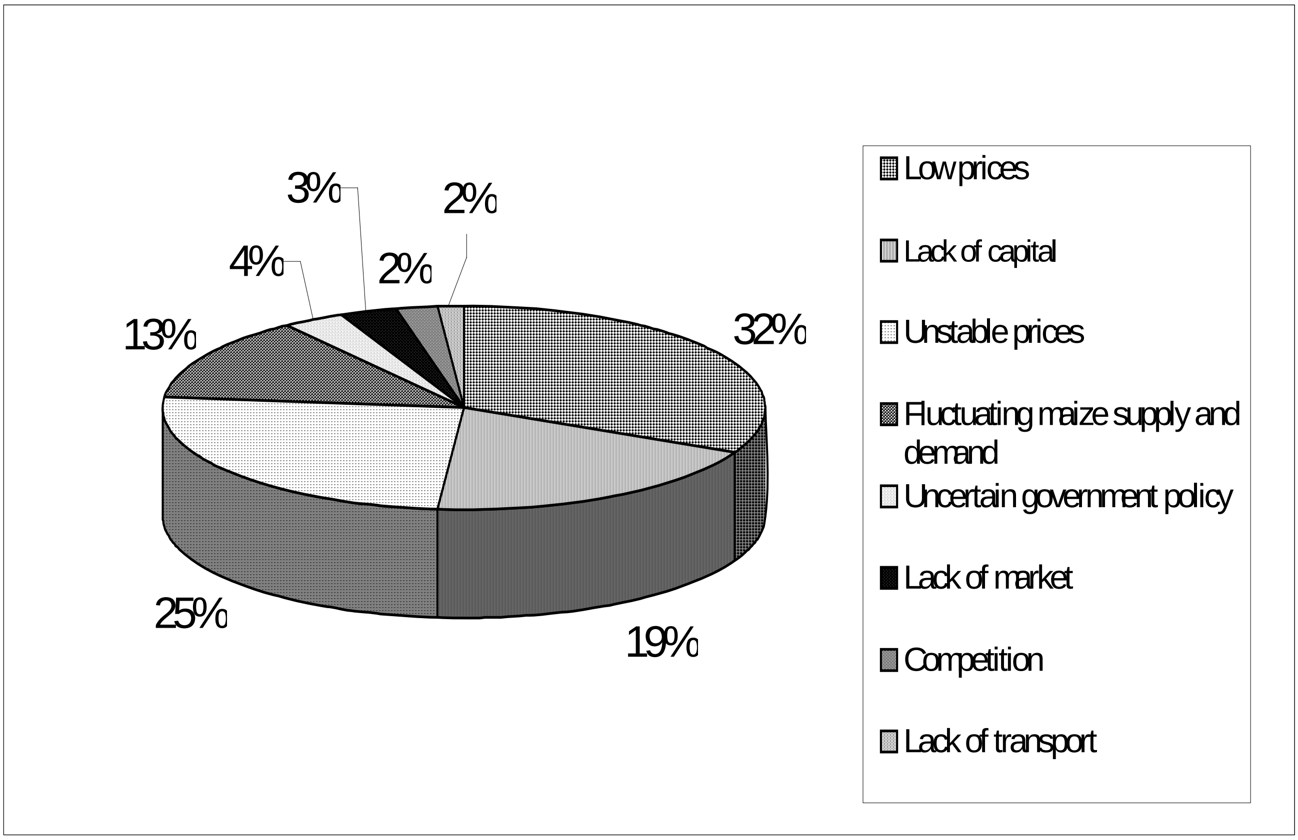


Figure 8: Problems experienced in acquiring credit



Source: Authors' Survey, 2001.

Figure 9: Maize marketing problems since liberalization



Source: Authors' Survey,2001

CHAPTER SIX

Grain Marketing in Addis Ababa, Ethiopia

Mulat Demeke and Tadele Ferede

Grain Marketing in Addis Ababa, Ethiopia

1. INTRODUCTION

Following decades when the state was widely assumed to be central to any development effort, the development community advocated a move away from state intervention in economic activity and a freeing of markets. The aim has been to unleash the creative forces of private entrepreneurship, in particular within smallholder agriculture and indigenous trading systems. A substantial effort in development policy analysis focused on “getting prices right” within the broader framework of structural adjustment programs (SAPs).

The production response to liberalization was, however, somewhat disappointing in Sub-Saharan Africa. The reasons for the lack of adequate response can be classified into three main groups (Dorward, Kydd, and Poulton 1998). The first explanation is that reform measures rarely went far enough to achieve the desired impact. The “market optimists–state pessimists” such as the World Bank (1994) argued,

> A top priority for reform in Africa is to increase competition through domestic deregulation, trade reform and the privatization of public enterprises. For example, marketing boards should be abolished, public enterprises privatized and import restrictions replaced by tariffs

---

A second explanation for the apparently disappointing response to market liberalization was that the African private sector had only weak potential to provide the services previously provided by state organs. The “market pessimists” noted that the observed vitality of small-scale, informal sector activity was insufficient evidence to prove the existence of private entrepreneurs who could assume roles of national economic importance—for example, in the marketing of staple foods to feed rising urban populations. Private traders, often discriminated against and harassed for decades, did not possess the managerial skill, business experiences, or capital to move straight into large-scale activity. In many places, indigenous entrepreneurs had never fulfilled these roles, even prior to Independence. Rather, these roles had been carried out by ethnic minorities, such as South Asians and Lebanese. One of the aims of nationalist, post-independence governments had been to prevent such groups from achieving economic dominance, given the weakness of indigenous entrepreneurs.

Besides this ethnic angle, there were other reasons why private enterprise alone might be reluctant to take on some of the former activities of parastatal organizations. In rural areas, for example, smallholders are often geographically dispersed, roads and communications are poor, and the volume of business is insufficient to encourage private service provision. Moreover, services such as research and extension have clear public good properties, which will tend to discourage private sector involvement. There are, in other words, high probabilities of market failure in key liberalized markets. Other services, such as wholesale grain trade and some agricultural processing operations, exhibit significant economies of scale, such that, even where private operators provide services, the market may not be competitive and prices offered to farmers may be depressed because the traders are very small.

A third, related explanation argues that the state has failed in promoting market development. A more activist role for the state is required in creating an enabling environment for private sector investment in market infrastructure. In Malawi, for instance, the road infrastructure is not well developed to facilitate mobility of traders and consumers. Many traders lack lines of credit from financial institutions for investment or bridge financing for purchases. At the same time, marketing boards have continued to dominate food marketing in many regions. Uncertainties surrounding the actual role of the state marketing boards have discouraged private trade (Chirwa 1998). In Tanzania, the government has not been able to offer much help to individual traders (Seppala 1998). Apart from limited investment in transport and communication, many governments in Africa and other developing countries have paid little or no attention to improving the food supply and distribution systems in the urban centers. According to FAO (1998), "General improvement of the supply and distribution systems has rarely been seen as a policy priority in most developing countries. Policies have focused instead on subsidizing basic foodstuffs, and on direct food distribution programs for poor population."

1.1. Background

Despite some improvements following liberalization, grain marketing systems in Ethiopia are characterized by lack of modernization, a limited number of large interregional traders with adequate storage and working capital, high handling costs, an inadequate market information system, weak bargaining power, and an underdeveloped processing industrial sector. Trading practices at the central market of Addis Ababa lack competitiveness and transparency.

It appears that brokers at the central market of Addis Ababa set the market price for each type of grain they receive from regional traders. The price discovery functions of the brokers involve setting a price after taking into account the previous day's closing price and evaluating the day's supply and demand conditions. Each broker independently sets a price (on average seven prices daily) and then informally conducts a survey of prices simultaneously announced by other brokers handling the same type of grain from the same origin, after which the broker may adjust his price upward or downward. This process of tatonnement is said to result in a single daily spot price (Gabre-Madhin 1998). But preliminary discussion with some brokers at the central market revealed that there are no single daily prices. Prices tend to vary with each transaction, depending mostly on the bargaining power of sellers and buyers. The marketing system seems to involve an informal negotiation between individuals (see Annex I.1) for the different categories of price discovery). Casual observation also showed that many brokers at the central market are at the same time wholesalers with their own storage facility. This may lead to a conflict of interest, as brokers may not strive for highest possible price if they are also buyers of the grain, which they are expected to sell on behalf of regional traders. In general, the whole process of price discovery at the central market deserves further study and more focused analysis to recommend improvement measures.

The bargaining power of regional grain traders (suppliers to the central market) on the one hand and wholesalers and processors and other buyers of grain on the other hand is not clear. Grain unsold on a given market day may remain on truck (at the marketplace) or may be unloaded in a nearby "shaded area" or store, and both options involve considerable charges for the regional traders (Dessalegn, Jayne, and Shaffer 1998). Congestion due to lack of space (the marketplace was built under the Hailesellasie government when the population of the city was probably less than one third of its current size) and inadequate storage seem to have contributed to the high charges. Sellers may decide to sell their grain at any price rather than incur such additional costs. Wholesalers seem to have the advantage of buying at low prices (given the weak bargaining power of sellers), but they may be constrained by lack of capital and storage. Moreover, many retailers and other buyers do not seem to use the services of wholesalers, but rather buy directly from the trucks parked at the central market. A number of final consumers also buy from farmers (who came from surrounding areas of the city) who sell grain in the small markets located throughout the city. The chain in the supply of grain seems to be complex and inefficient. There is a need for a rigorous evaluation of the manner in which the Addis Ababa central grain market operates.

1.2. Grain market studies in Ethiopia

A few studies have looked into the performance of Ethiopia's grain marketing system after the market liberalization of the 1990. Lirenso (1993) conducted a small-scale survey of farmers and traders in Chilalo, Ada, and Addis Ababa and showed that marketing margins generally declined after the deregulation of grain markets. The study revealed that the returns to trade were lower than other businesses given the risks of transporting grain over space and storing it over time. Lack of working capital and financial credit was among the major barriers to entry, according to the study.

Amha (1994) analyzed the marketing system in southern Ethiopia using the industrial organization model. He concluded that private grain trade has become competitive and more efficient and that grain markets at local and national levels have become more integrated following the deregulation of the grain market. He reported, however, that spatial price spreads were higher compared with the estimated transfer costs and that the cost of transporting grain from rural to urban markets was particularly high for small trucks. Seasonal price differences were high compared with the estimated storage costs.

KUAWAB Business Consultants (1994) carried out a survey of nonrandomly selected farmers, traders, and institutions in both grain-surplus and -deficit areas of the country. The study showed that although the degree of competitiveness varied from place to place, the markets generally appeared to be more competitive. It also concluded that the returns to transport and storage were about normal, suggesting that transport and storage functions were carried out with reasonable efficiency.

Sinke and Demeke (1995) analyzed market integration after the 1990 reform using secondary and primary data from a survey of rural markets in the Arssi zone. The results showed that food grain marketing efficiency needs to be improved through a combination of policy measures including improving infrastructure, particularly rural roads; providing rural-based price information; checking the activity of unlicensed intermediaries; and re-evaluating the price stabilization scheme of the government.

Based on secondary price and other data, Negassa and Jayne (1997) concluded that cereal price spreads (the difference between wholesale prices in major regional markets) in Ethiopia have generally declined since liberalization in 1990. The correlation between wholesale market prices has risen in 17 of the 24 market pairs examined. Similarly, volatility, as measured by standard deviation of grain price levels, declined in 11 of 16 cases examined, while the volatility in price spreads declined in 23 of the 24 market pairs examined. The study concluded that while liberalization may have improved allocative efficiency and reduced marketing costs related to policy restrictions, there may be substantial scope to improve the technical efficiency of marketing activities by strengthening market institutions. This implies a positive role for government improving road, rail, port, and communication infrastructure; removing taxes on grain at regional road checkpoints; improving public market information systems; nurturing the political and legal foundations of marketing systems; and investing in local analytical capacity.

The 1998 GMRP study (Dessalegn, Jayne, and Shaffer 1998) is the most comprehensive research on the grain market to date. It covered a random sample survey of 4,000 rural farm households and 220 wholesale grain traders, drawn from all over the country. One of the main findings of the research is that the grain wholesale trade is dominated by a small percentage of merchants; the largest 10 percent command about 43 percent of the volume traded at wholesale level. Small merchants are subjected to low capital turnover. This situation has negatively affected the competitiveness of the market. Moreover, the price spread between Addis Ababa and many regional markets can be considered adequate only after attributing nonmonetary transaction costs of about 30 percent over and above the monetary costs. Similarly, there seems to be substantial seasonal variation, which reflects storage costs only after including a fairly high implicit risk premium for temporal arbitrage. The study also showed that the grain-buying price at the local markets is mostly determined by deducting miscellaneous costs and a net traders' profit margin from the prevailing wholesale price in Addis Ababa. Intermarket grain flow is coordinated mainly by the brokers in Addis Ababa, who specialize by route and coordinate grain buying, selling, transporting, and pricing activities. Among the major constraints identified by traders are checkpoint taxes, lack of financial credit, absence of control on unlicensed traders, unavailability of transport services and high transport tariff, lack of adequate storage facilities at appropriate locations, and lack of market information.

Gabre-Madhin (1998) examined the consequences of transaction costs of searching for a trading partner on the emergence of the institution of brokerage in the Ethiopian grain market. Brokers facilitate long-distance trade by enabling traders to minimize the risk of commitment failure in a market with little public information, nonstandardized grain, no official inspection, and limited legal enforcement. While 85 percent of grain traders regularly use brokers, who handle 38 percent of the marketed surplus countrywide, the degree of traders' dependence on brokers varies by region and type of transaction. Agency relations between traders and brokers are not based on ethnic ties but appear to be sustained by established norms that limit cheating by brokers despite the difficulty that traders have in monitoring brokers. The results of the empirical analysis revealed that traders with high costs use more brokerage whereas traders with high social capital search on their own, showing that traders rationally use brokerage to minimize their individual transaction costs. The study recommended grain standardization and inspection, bulk handling of grain, grain contract standardization, commercial arbitration, and grain exchange in the long term.

Amha (1999a), using the same database as that used by Dessalegn, Jayne, and Shaffer (1998) and wholesale price data of Ethiopian Grain Trade Enterprise (EGTE), reported that the reform improved the efficiency and flow of maize into markets. The results of the co-integration test showed that there was short-run and long-run integration between Addis Ababa and some of the major markets in the country. The study called for selective government intervention aimed at developing market centers, disseminating price and production information, implementing quality and grade standards, improving the legal system and infrastructure, and supporting the development of private grain trade. Amha

(1999b) reviewed the market systems and stressed, among other things, the need to create a conducive and enabling environment, train grain market operators and entrepreneurs, and improve grain market information systems.

In general, most of the grain market studies seem to have focused on the impact of liberalization and on price integration between the different market centers of the country. The results, though conflicting in some cases, confirmed that market integration and efficiency improved during the post-liberalization period. At the same time, the studies tend to suggest high spatial and seasonal price differentials. The general consensus is that there is room for further reduction of costs.

The importance of the Addis Ababa central market (Ehil Berenda) has been underscored in many of the grain market studies conducted so far. For instance, Gabre-Madhin (1998), in her descriptive analysis of the market structure, observed the radial structure of roads in Ethiopia (with the capital city at the center) and showed that the regional markets cannot trade directly with each other without physically passing through the capital city, Addis Ababa. The central market of Addis Ababa serves as a national clearinghouse of grain, with sellers bringing in grain and buyers coming to acquire grain. Transaction and transport costs are therefore very high, implying wide a margin between farmgate and consumer prices in food-deficit areas.

1.3. Purpose and objectives

The volume of grain marketed falls sharply in years of poor harvest, and as a result prices rise considerably. On the other hand, grain prices are seriously depressed in good years and immediately after harvest. Low prices immediately after harvest and high seasonal price fluctuations have discouraged investment in inputs such as fertilizers and improved seeds.

Inefficient and underdeveloped output markets result in low and variable prices, thereby reducing the profitability of new technologies for farmers, discouraging business people from investing in processing activities, and deterring wholesalers, retailers, and transporters from investing in improved market and transport services. In addition, the distribution system may be inadequate and expensive for final consumers. The purpose of this research is to shed light on how the Addis Ababa central grain market operates. It will contribute to the understanding of factors hindering improvement and modernization of the market.

The objective of this study is to examine the competitiveness and efficiency of the Addis Ababa central grain market. A more efficient, responsive, and modern central market could bring substantial welfare gains to producers, consumers, processors, and other participants all over the country. More specifically, the research will

- investigate and describe the role of brokers, grain sellers, and buyers in the process of price discovery;
- provide insights into the structure, conduct, and performance of the brokerage, wholesale, and retail markets;
- assess the effectiveness of the different channels through which consumers buy grain;
- examine the role of associated public and private institutions and transaction costs in the performance of the marketing system; and
- derive policy implications that will help policymakers understand the factors hindering improvement and modernization of the Addis Ababa central market.

1.4. Research questions

This study is intended to address a number of empirical questions. The first set of questions concerns the characteristics of traders. What is the mix of petty and large-scale traders? If petty traders dominate the market, do they have the financial resources and storage capacity to tackle seasonal price fluctuations? Are small-scale traders professional or seasonal/part-time? Do large-scale traders have networks among themselves and with brokers, and are large-scale traders linked with producers and processors?
The second area concerns buying and selling practices.[1] Are there formal and informal marketing or producer groups that affect bargaining power? What buying practices are in place (e.g., auction sale, contract sale, or first-come/first-serve)? What distribution channels are used? Are traders capable of providing marketing services for the whole country at reasonable prices? Are there observed unethical trading practices (e.g., short weights, misleading price quotations, usurious practices)? If suppliers' credit is provided, what are the frequency and terms of payment?

The third set of questions concerns pricing behavior. Who sets prices (e.g., one buyer or many buyers)? How are prices set (what is the degree of personal contact among market participants)? What is the basis for price differentiation? How do prices adjust under the prevailing market conditions? Are there constraints in the use of specific market channels? Does the physical location of the market affect prices and marketing arrangements?

The fourth area of investigation is the relationship between regional traders (supplying the central market) and brokers. How does the principal-agent arrangement influence the conduct of the market? How is conflict of interest avoided when brokers also act as wholesalers? Do wholesalers have the capacity to buy from regional traders and then supply all buyers at the central market (both retailers and large consumers)?

The fifth area is private traders' effectiveness and competitiveness. Competitiveness and the integration of markets can be analyzed through the variability of prices between locations and between seasons. What are the determinants of daily market prices? Are the market margins excessive? How do processors and consumers feel about the grain marketing services?

Sixth, civil society organizations have been given a prominent role in recent discussions on liberalization. Are there trader organizations that safeguard traders' interests or provide basic services, such as credit facilities and business training? How do the Addis Ababa and the national chamber of commerce assist grain traders?

Finally, private traders are always subjected to government policy measures. The policy environment consists of regulatory measures, support measures, and taxation. Regulatory measures strive to enhance competition among traders and, at the same time, to guarantee the minimum quality of the product. Is the policy environment conducive to grain trade? Are there barriers to entry and exit, expansion, and modernization associated with policy and

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1 See, for instance, R. S. Pomeroy and A. C. Trinidad, Industrial organization and market analysis: Fish marketing, in *Prices, products, and people: Analyzing agricultural markets in developing countries*, ed. G. I. Scott (Boulder, Colo., USA: Lynne Reinner: 1995).

legal requirements? Are there differences between the official stipulations and the actual demands of the field? What are the different support measures used to promote grain trade?

1.5. Methodology

1.5.1 Description of dataset

For the reasons already described, the focus of this study is the Addis Ababa central grain market. Although a number of cereals, pulses, and oilseeds are traded at the central market, only *teff*, wheat, and maize have been selected for the study because of their importance in total grain trade. There are different grades within each crop type. For instance, there three major origins of *teff*: *Adda*, *Wollonkomi*, and *Gojjam Bechena*. Within each origin, various grades can be identified: three grades for *Adda*, four grades for Wollonkomi and Gojjam/*Bechena teff*. Similarly, only four grades for wheat and two for maize can be identified based on color and uniformity.

Both secondary and primary data have been collected. Primary data were collected through a market survey using a structured questionnaire for traders and price observation. The survey was conducted during March 2002 to June 2002. The main focus was the central grain market and merchants who buy and sell grain; brokers and transporters operating at or visiting this market were also included in the survey. Initially, a list of traders was obtained and a random sample was drawn from the list. The focus was limited mainly to brokers, retailers, regional traders, and transporters. Accordingly, a random sample of 67 brokers, 107 retailers, 32 regional traders, and 20 grain transporters dealing with the three crops at the central grain market were interviewed. Retailers also include small flourmill operators engaged in selling grain. Different questionnaires were designed for each occupation category,i.e, brokers, retailers, regional traders and transporters covering major issues such as basic background information, working capital requirement, price determination, volume of transactions and commissions, grading, access to credit, regulatory framework and policy, sources of information, barriers to entry, and marketing problems.

Finally, wholesale and retail prices were also collected from traders during March to July 2002. The daily prices of each grade of *teff*, wheat, and maize were collected between the opening (6:00 a.m.), middle (7:30 a.m.) and closing (9:00 a.m.) of market operations.

1.5.2. Data analysis

Analysis of data involves qualitative evaluation as well as quantitative analysis (descriptive statistical and econometric techniques). All the major factors that wholesalers/brokers consider in setting prices and the extent to which prices are influenced by major traders have been examined to establish whether price leadership or collusion exists at the central market. A hedonic model was used to identify the determinants of the daily price of the different crops. In addition, instability indexes have been constructed for each crop and grade to see the behavior of prices (both retail and wholesale) over time. And market integration analysis has been conducted to assess grain market integration.

1.6. Organization of the report

This study is organized in seven sections. Section 2 deals with the structure and functioning of grain brokers at the central market. Sections 3 and 4 discuss the characteristics of retailers and regional traders, respectively. Section 5 presents the pattern and adjustment of grain prices at the central grain market, while section 6 deals with large-scale operators. Finally, conclusions and policy implications are presented in section 7.

2. STRUCTURE AND FUNCTIONS OF GRAIN BROKERS

The use of an intermediary to carry out a transaction can generally be accounted for in terms of opportunity cost and imperfect knowledge. If buyers and sellers were obliged to make contact directly, the costs of executing transactions could be prohibitively high. Buyers and sellers lack the necessary time and information to undertake exchange transactions. Grain brokers at the central grain market serve as the focal point for a seller who wants to get a buyer and as the agent of a buyer who wants to get a seller. The principal function of a broker is to find the opposite side of their clients' orders and obtain the best possible deal.

Brokerage activities at the central market for the sale of grain transported from the regions start at 6:00 a.m. and end at 9:00 a.m.. The major market days are Monday, Wednesday, and Friday. Loaded trucks converge in the crowded marketplace, and buyers visually inspect the quality of grain and negotiate with brokers over prices. Trucks with unsold grain leave the space at about 9:00 a.m. to make way for wholesale and retail activities by brokers and other traders. The trucks stay within the vicinity of the central grain market and return to the market's parking lot late in the afternoon for the following market day. Truck operators wait for a maximum of three days, after which the grain is unloaded at a given store. Lack of space at the central market has limited the trading of grain transported from the regions to three hours a day.

2.1. Brief profile

A total of 67 brokers operating at the central market were interviewed. These brokers have licenses for grain trading and pay taxes to the government. The other category of brokers, also known as informal brokers, perform a similar function but have no trade license or stall, and they are not included in the survey. They have no address or clients but search for casual buyers and bring them in contact with regional traders who do not need to go to the central marketplace and operate without the assistance of a formal broker.

Formal brokerage is exclusively handled by men; no woman was reported to have a brokerage firm. This might be due to the fact that brokerage requires intense physical movement (brokers have to run here and there and confront each other over attracting buyers).

A significant proportion of the brokerage businesses (79 percent) had been established since 1991 (Table 2.1). The number of private brokers was very limited until the beginning of market reform in 1991. Private businesses were highly discouraged in the 1980s because of the socialization policy then in effect. Most operators have only about six years of experience in the business. Brokers were also asked about how they started the business. A high percentage of brokers, about 84 percent, established or set up their own business, whereas 12 percent inherited the business from their parents or relatives (Table 2.2).

Table 2.1: Year of establishment

Year	Number of brokers	%
Before 1974	5	7.5
1975–90	9	13.4
Since 1991	53	79.1
Total	**67**	**100.00**

Source: Survey, 2002.

Table 2.2: Means used to start the business and source of initial capital

Description	Number	%
Means to start business		
Set it up/established it myself	56	83.6
Inherited	8	11.9
Bought	3	4.5
Total	**67**	**100.0**
Source of initial capital		
Own or self	39	58.2
Gift from family	1	1.5
Bank loan	1	1.5
Borrowed from relatives and friends	7	10.4
Other	19	28.4

Source: Survey, 2002.

The average capital required to start the business was about birr 12,873, and the main source of initial capital was own funds, followed by borrowing from relatives or friends. Formal financial institutions supplied start-up capital for only 1.5 percent of the cases (Table 2.2).

Many of the sample brokers (58 percent) performed their activity on premises rented from the government, while the rest (40 percent) rented from individuals who had rented from the government (Table 2.3). The premises are used to keep unsold stock and to undertake wholesale and retail activities after 9:00 a.m. The average size of stalls is very small—only 34 square meters—and costs an average of birr 437.80 a month. One of the brokers has no stall, implying that brokerage may not necessarily require a stall unless a broker has an interest in retailing or wholesaling activities.

In addition to brokerage, the sample brokers perform grain retailing, wholesaling, milling, and the like. Grain retailing and wholesaling are performed by 21 percent and 96 percent of the cases, respectively (Table 2.4). It appears that brokers are also wholesalers and retailers at the same time. This is inconsistent with the earlier finding that brokers do not trade on their own account (Gabre-Madhin 2001). Gabre-Madhin argued that brokers do not bear market price risks since they do not trade on their own account, with less 10 percent of transactions made for themselves.

Table 2.3: Ownership type and premise (stall) used

Ownership type	Number (%)
Rented from private individuals	27 (40.3%)
Rented from government	39 (58.2%)
Without stall	1 (1.5%)
Total	**67 (100.0%)**
Stall size and rent	
Average size of stall (square meters)	34.49
Average monthly rent payment	437.80

Source: Survey, 2002.

Table 2.4: Other activities performed by brokers

Activity type	Yes	No	Total
Grain retailing	14 (20.9%)	53 (79.1%)	67
Grain wholesaling	61 (95.5%)	6 (4.5%)	67

Source: Survey, 2002.

The educational level of people working for the brokerage firms is very low: only 21 percent of the workers had completed secondary school, whereas the rest have a primary and incomplete secondary education. The majority of the workers (99 percent) had received no training on how to improve their marketing activities in the preceding three years.

The evidence shows that brokers operate with limited financial resources and inadequate management skills. Stiff competition among too many formal brokers and between formal and informal brokers has reduced the amount of grain handled by each broker and the profit margin. Brokers diversify into related activities such as retailing and wholesaling to supplement their income from brokerage, although this practice is likely to result in conflict of interest. As long as a broker is also trading on his own account, the possibility of retaining the grain of a client (a regional trader) for future sale at a higher price cannot be ruled out, especially when prices are low and a buyer is not readily found. Regional traders have no association or power to prevent the involvement of brokers in activities that are not consistent with their brokerage responsibilities. They are also too far away to monitor the different transactions involved in selling their grain.

2.2. Interaction with major actors

Emerging evidence has shown that social capital and trade networks play important roles in trade and critically determine the success of a business under conditions of information asymmetry. The term social capital signifies many dimensions, including number of trading contacts and ability to maintain and retain regular clients (or what is called *dembegna*). The extent of interactions with different stakeholders is discussed next.

2.2.1. Interaction with regional traders

In principle, brokers must try to sell grain sent by regional traders at the highest possible price and within the shortest period of time. The process requires frequent interaction to facilitate the sales transaction. Telephone is the main means of communication for 54 percent of the sample respondents, whereas regional traders' personal visits to the central market are the main means for 43 percent. Interaction is clearly constrained by limited access to telephone. Other modern means of communication such as fax and Internet are virtually unknown (Table 2.5).

Table 2.5: Major means of communication

Means of communication	%
Telephone	54.0
Hand-delivered **[messages?]**	2.7
Personal visit	43.3
Total	100.0

Source: Survey, 2002.

Brokers' interaction with regional traders is largely limited to information about prices, quality, and quantity (Table 2.6). Price is the only major information used for decisionmaking. Details about demand and supply are vital, but the trading system and the communication technology cannot handle such information. The scope of information exchange is too limited to allow for conducting effective sales transactions and assisting in longer-term decisions.

Table 2.6: Content of communication with regional traders

Content of communication	Yes	No
Prices at regional market	29(43.3%)	38 (56.7%)
Prices at central market	64 (95.5%)	3 (4.5%)
Quantity of grain to be shipped	41 (61.2%)	26 (38.8%)
Quality of grain to be shipped	52 (77.6%)	15 (22.4%)

Source: Survey, 2002.

Brokers believe that most regional traders (93 percent) have adequate information[2] about grain prices at the central market (Table 2.7). In spite of problems of communication, brokers at the central grain market appear to face difficulties if they try to understate the price at which grain has been sold. Regional traders may also switch to another broker if they are not satisfied with the price secured by their broker. Brokers report that they have lost, on average, two clients (regional traders) during the preceding 12 months.

Table 2.7: Regional traders' information about grain prices

Grain price information	%
Most have adequate information	93.2
Most do not have enough information	2.1
Most have no information	4.8
Total	100.0

Source: Survey, 2002.

Brokers were also asked about how they handled unsold stocks. They reported various mechanisms, including storing grain in their own stall and selling it to buyers in smaller quantities, storing it in a rented warehouse, and selling it on credit to regular clients or buyers (Table 2.8). It should be noted that storage involves costs in the form of rental charges. The average storage cost, for instance, was birr 1 per quintal if grain was stored in a rented warehouse. Apart from the additional cost of storage and unloading and loading, regional traders would face cash shortages in trying to buy grain from farmers while their money was tied up with the unsold grain. Hence, most would prefer selling at very low prices rather than storing the grain for sale in the future. Some regional traders were happy if brokers paid them cash from their own sources and sold the grain later on their own account, given their desperation to get cash for purchasing in the next round.

Table 2.8: Methods of handling unsold stocks

Method	Yes	No
Store and sell to buyers in smaller quantities	74.2	25.8
Store in rented warehouse	71.2	28.8
Sell on credit to regular buyers	81.8	18.2
Store and sell to buyers in larger quantities	100.0	0.0

Source: Survey, 2002.

2 Although prices have been collected by different organizations, such as Central Statistical Authority (CSA) and Ethiopian Grain Trade Enterprise (EGTE), there is evidence that private traders have no access to grain market information. The Ethiopian Grain Market Research Project (GMRP), together with Michigan State University, used to disseminate grain price information by radio, but public dissemination of price information has now been discontinued.

There are no official quality controls and standards at the central market. An independent grading and inspection agency to assist both buyers and sellers has never been part of the trading system in the country. In situations where there is no agreement over the quality of grain, a broker seems to have the final decision. Indeed, about 74 percent of the sample brokers confirmed that grain is sold at a grade determined by themselves. As shown in section 2.2.3, brokers and buyers negotiate to determine grade levels. Only 10 percent of the respondents reported that grain is sold at a grade determined by regional traders (Table 2.9). Regional traders have a weak bargaining position vis-à-vis brokers at the central market.

Table 2.9: Decision regarding grades

Source of decision regarding grade	Number	%
Grade determined by the broker	43	74.1
Grade determined by regional trader	6	10.3
Depends on market (negotiation)	9	15.5
Total	58	100.0

Source: Survey, 2002.

2.2.2. Relations among brokers

A broker can contact, on average, 10 brokers during any given market day. The main mode of contact includes direct personal interaction and telephone dialing to friendly brokers, and indirect intelligence gathering from other brokers (Table 2.10). Brokers regularly contact friends who operate in a nearby stall. The main purpose of the interaction is to get some ideas about prices (60 percent), although a significant proportion (42 percent) also had the intention of agreeing on prices. The possibility of collusion among brokers does exist, implying that grain could be sold at higher price than what the brokers are willing to report to their clients (regional traders).

Table 2.10: Contact with other brokers

Indicator	Yes (%)	No (%)
Method of contact		
Direct personal contact	86.6	13.4
Through telephone	65.7	34.3
Through intelligence gathering	28.4	76.6
Indirectly via intermediaries	23.9	76.1
Purpose of contact		
To agree on a certain price	41.8	58.2
To get an idea about prices	59.7	40.3
To get information about quantity of grain	49.3	50.7
To get information about type of regional traders	26.9	73.1

Source: Survey, 2002.

There is also a close relationship between formal and informal brokers.[3] About 60 percent of the formal brokers reported that they have a smooth relationship with informal brokers at the central grain market. In fact, informal brokers assist by bringing in buyers, attracting new suppliers, gathering price information, and providing information on buyers (Table 2.11). About 95 percent of the brokers reported that the main function of nonlicensed brokers was to bring in buyers, whereas 48 percent reported that informal brokers collected price information. Brokers pay informal brokers mainly on a commission basis (65 percent). Some brokers (40 percent) do not pay on the grounds that informal brokers are paid by the other party (the buyer) (Table 2.11).

It has also been reported that informal brokers directly deal with regional traders before their trucks take positions at the central market. This is possible if informal barokers have already located a buyer who is willing to buy outside the central market. The seller incurs less cost by avoiding paying the cost of parking, the charge at the gate of the central market, and the relatively higher commission charges of formal brokers. There are also gangsters who act as brokers and take unsuspecting buyers to their partners who sell gain mixed with sand and other impurities.

Table: 2.11: Services of informal brokers and mode of payment

Functions of informal brokers	Yes	No
Bring in buyers	38 (95.0%)	2(5.0%)
Bring in new suppliers	15 (37.5%)	25(62.5%)
Gather price information	19 (47.5%)	21 (52.5%)
Gather information on supply	13 (32.5%)	27 (67.5%)
Gather information on buyers	16 (40.0%)	24 (60.0%)
Mode of payment		
On commission basis	26 (65.0%)	14 (35.0%)
Fixed rate per day	2 (5.0%)	38 (95.0)
No payment (they are paid by other party)	16 (40.0%)	24 (60.0%)

Source: Survey, 2002.

2.2.3. The bargaining power of buyers

The main types of buyers that visit brokers' stalls at the central market are retailers, flourmill operators, flour factory owners, and private wholesalers (Table 2.12). Retailers and operators of flourmills come from different parts of the city. Private wholesalers are traders who transport and sell relatively large quantities of grain in major food-deficit towns such as Dire Dawa or Mekelle (Tigray).

[3] The term "formal brokers" refers to licensed brokers with their own stalls, while "informal brokers" refers to those with no stall, and hence unable to serve as brokers for regional traders.

Table 2.12: Type of buyers frequently visit brokers' stall

Buyer type	Yes	No
Retailers	48 (71.6%)	19 (28.4%)
Flourmill operators	54 (80.6%)	13 (19.4%)
Flour factory owners	34 (50.7%)	33 (49.3%)
EGTE	6 (9.0%)	61 (91.0%)
Private wholesalers	39 (58.2%)	28 (41.8%)
Institutions (DPPC, NGOs, etc.)	14 (20.9%)	53 (79.1%)
Hotels, hospitals, schools, army, etc	15 (22.4%)	52 (77.6%)

Source: Survey, 2002.

The sample brokers revealed that most buyers come with adequate information about the prevailing market prices. Buyers may also check prices by asking different brokers, retailers, and wholesalers before their final decision. It is also customary to bargain for lower prices. A few buyers come with limited information and hence they are in a weak bargaining position vis-à-vis sellers (brokers) and pay relatively higher prices (Table 2.13).

Some buyers try to influence grain prices mainly by bargaining for lower prices, reducing the quantity of their purchase, postponing purchase decisions, and switching to other brokers (Table 2.14). These practices have a depressive impact on prices, especially when supply exceeds demand. For instance, postponing purchases could mean that supplies accumulate and the central market becomes jammed with an excessive number of trucks. Some buyers may even collude among themselves to set prices.

Table 2.13: Buyers' information about grain prices

Buyer type	Most come with adequate information	Most come with limited information	Most come with no information
Retailers	45 (91.8%)	3 (6.1%)	1 (2.0%)
Flourmill operators	44 (81.5%)	10 (18.5%)	0
Flour factory owners	23 (69.7%)	9 (27.3%)	1 (3.0%)
Ethiopian Grain Trade Enterprise (EGTE)	4 (100.0%)	0	0
Private wholesalers	33 (86.8%)	3 (7.9%)	2 (5.3%)
Institutions (Disaster Prevention and Preparedness Commission [DPPC], NGOs, etc)	6 (46.2%)	5 (38.5%)	2 (15.4%)
Hotels, hospitals, schools, army, etc.	8 (53.3%)	6 (40.0%)	1 (6.7%)

Source: Survey, 2002.

Table 2.14: Buyers' methods for influencing grain prices

Method	Yes (%)	No (%)
Postponing purchase decisions	52.2	47.8
Reducing quantity of purchase	53.7	46.3
Bargaining for lower prices	85.1	14.9
Seeking for other brokers	50.7	49.3
Buyers forming a group to set prices	48.5	51.5

Source: Survey, 2002.

A large buyer (e.g., the DPPC, hospitals, universities) could influence grain prices using open bids. Since the quantity involved is relatively large, brokers are tempted to lower prices and win the bid. Moreover, brokers use different mechanisms to attract buyers, such as offering better-quality grain, providing credit services, and improving services (Table 2.15). The pressure to get buyers is very high, especially at times of excess supply. In recent years credit sales are becoming the dominant sales strategy at the central market. For example, 66 percent, 40 percent and 68 percent of *Adda teff, Wollenkomi teff* and *Bechena teff* were sold on credit, respectively, during the month of February 2002. Credit sales require consulting the owner of the grain (regional trader) in most cases.

About 36 percent of brokers reported that they charge a price 5–13 percent higher when they sell on credit. Credit sales involve high risk for brokers, however. Defaults are common due to lack of enforcement mechanisms. In fact, about 78 percent of the sample brokers confirmed that they had lost money over the preceding three years because some of their clients defaulted on their loans. Brokers, on average, had lost birr 21,763 over the preceding three years, and none of them had ever taken defaulters to court (Table 2.16). This is because the transaction is essentially based on mutual trust with no written contract to enforce repayment. Those who lost money as a result of such incidents are likely to lose their clients as they fail to pay them. Some of the better-off brokers do not sell on credit; they can store grain for some time and pay regional traders from their own money.

Table 2.15: Brokers' strategies for attracting buyers

Method	Yes (%)	No (%)
Offer lower prices	19.4	80.6
Offer better-quality grain	92.5	7.5
Offer credit services	73.1	26.9
Use agents to bring buyers	34.3	66.7
Provide reliable services	86.6	13.4

Source: Survey, 2002.

Table 2.16: Have you faced disputes with buyers in the past three years?

Brokers' response	Number	%
Yes	52	77.6
No	15	22.4
Total	67	100.00

Source: Survey, 2002.

Lack of grading provides an additional edge to buyers in the process of bargaining. Buyers often dispute grades set by brokers or regional traders. Because of the pressure to sell, brokers often agree to the lower grade asserted by buyers. In fact, about 59 percent of the sample brokers indicated that the quality of grain is determined by buyers, and only 25 percent indicated that quality of grain is determined through negotiation. Large-scale buyers certainly have a stronger position vis-à-vis the brokers, especially when there is excess supply in the market.

2.2.4. The role of transporters

On average, transporters wait for two to three days until the grain is sold at the central market. About 97 percent of brokers reported that transporters press brokers to sell the grain as quickly as possible. Apart from the opportunity cost of losing working time, many transporters want to avoid costly hotel bills when they stay in Addis Ababa. Besides bringing grain to the central market, truck drivers are often responsibile for delivering the money from brokers to regional traders. About 48 percent of the brokers send money to regional traders though truck drivers (Table 2.17).

Table 2.17: Do brokers send money for regional traders via transporters?

Response	Number	%
Yes	32	47.8
No	35	52.2
Total	**67**	**100.0**

Source: Survey, 2002.

About 53 percent of brokers do not assume any responsibility if money sent through drivers is lost (Table 2.18). Others (47 percent) reported taking responsibility for money lost in the process. Nonetheless, there is no legal means to enforce payment in all cases (no written contract), and the ultimate losers are regional traders. The main reason for using transporters to transfer money is absence of a banking service (Table 2.19). Fortunately, the majority of brokers (94 percent) experienced no incidence of fraud by transporters. Only 6 percent of brokers reported that they have faced betrayal by transporters (Table 2.20).

Table 2.18: Do brokers assume responsibility for money lost?

Response	Number	%
Yes	15	46.9
No	17	53.1
Total	**32**	**100.0**

Source: Survey, 2002.

Table 2.19: Reasons for using transporters for transferring money

Reason	Yes	No
No banks	23 (71.9%)	9 (28.1%)
No transaction cost	8 (25.0%)	24 (75.0%)
Regional traders' preference	7 (21.9)	0

Source: Survey, 2002.

Table 2.20: Have brokers experienced betrayal by transporters?

Response	Number	%
Yes	4	6.0
No	63	94.0
Total	67	100.0

Source: Survey, 2002.

2.3. Grading systems and access to storage and credit

A well-functioning grain market requires a system of grades and standards, as well as access to reliable storage and credit facilities, in order to reduce transaction costs. Inadequacies in such services have undoubtedly affected the performance of brokers at the central market.

2.3.1. Grading and standards

Brokers consider the origin of grain, seed purity, extent of germination, seed color, variety, insect damage, and season of harvest to arrive at grades (Table 2.21). Accordingly, there are at least three major origins of *teff*: *Adda* (around Debre Zeit, known as *Adda teff)*, which is considered the best-quality *teff* in the country. The second- and third-quality grain are *Wollenkomi* and Gojjam/*Bechena teff*, respectively. Different grades are also recognized within each type of *teff*: three grades (grade 1, 2, and 3) in the case of *Adda teff,* four grades in the case of *Wollenkomi,* and another four grades for Gojjam/*Bechena teff*. The grades are based on seed color (white, mixed, and red), seed purity, damage to the seed, and perhaps season of harvest. Price differences between the different origins and grades, as shown in section 5, are significant. The price of the highest grade of *teff*, for instance, can be 1.6 times the lowest grade (see section 5). Dealing with 11 different subjective grades in the case of *teff* alone on any market day is a huge task for brokers at the central market. It should be added that brokers and traders make a distinction between other origins of *teff* (e.g., Becho, Ancheni, Gooder, Arbaminch, and Kella), further complicating the task of grading and standardization.

Grade types are relatively simple in the case of wheat and maize. For instance, wheat types are decided based on three varieties (Israel, local [*abesha*], and white), and two grades (first and second) are identified in each case. Only three color-based grades (white, mixed, and black) are commonly identified for wheat, however. The origin (e.g., Gojjam, Wellega, Illubabor) and color (red and white) are considered in the case of maize. It is also common to find only two color-based maize grades (white and mixed) at the central market.

Table 2.21: Factors considered in grading grains

Factor	Yes	No
Origin	66 (98.5%)	1 (1.5%)
Seed purity	59 (88.1%)	8 (11.9%)
Seed color	62 (92.5%)	5 (7.5%)
Extent of germination	17 (25.4%)	50 (74.6%)
Moisture	34 (50.7%)	33 (49.3%)
Weevil	60 (89.6%)	7 (10.4%)
Season of harvest	53 (79.1%)	14 (10.9%)

Source: Survey, 2002.

There is no easy way of establishing the origin and other attributes of grain. The origin is largely left to claims by regional traders, while grades are usually determined through visual inspection and information supplied by regional traders (Table 2.22). Each sack or a sample of the total sacks (each weighing 100 kilograms) must be inspected with simple hook (to take a small sample of grain) or unbagged to establish quality and grade. Brokers do not use modern instruments mainly because of lack of awareness and know-how in using grading instruments.

Table 2.22: Method used to grade different grains and reasons for not using instruments

Method	Yes	No	Total
Visual inspection by brokers	67 (100.0%)	0	67
Use instruments	0	67 (100.0%)	67
Use information supplied by regional traders	38 (56.7%)	29 (43.3%)	67
Visual inspection by experts	2 (3.0%)	65 (97.0%)	67
Reason for not using modern instruments			
Not aware of any instrument	49 (73.1%)	18 (26.9)	67
Instruments are not affordable	44 (65.7%)	23(34.3%)	67
Lack of know-how in using instruments	44 (65.7%)	23(34.3%)	67

Source: Survey, 2002.

Buyers and sellers must negotiate over grades, not just prices, before transactions are effected. As already shown, buyers have an upper hand in setting grades and standards, compared with sellers, who are under pressure to get cash for the next round of purchasing. But not all buyers have such bargaining power. Uninformed or small buyers are likely to buy lower grades than what they are actually told by the sellers and also pay higher prices than the market price. Purchasers often look for well-known and regularly contacted brokers to get a fair deal. The central market works against buyers with little information and weak bargaining skill. Market information is also of little value in the absence of an objective system of grades and standards.

2.3.2. Access to storage

The storage capacity of brokers is very small: the maximum average storage capacity of the sample brokers was only 570 quintals at the central grain market). About 70 percent of the brokers reported that their storage space is not adequate, even though they are operating with a small amount of capital (Annex Table 2.9). Most brokers (70 percent) do not have clients that provide storage services, and 30 percent reported having such clients. Storeowners charge birr 2 per quintal per month on the average. The majority of the sample brokers (57 percent) felt that the storage charge was expensive (Table 2.23).

Brokers were asked about the quality of storage they rent. About 83 percent reported that the quality of the storage is average or adequate (Table 2.23). Although most brokers seem to think that the quality of storage is acceptable, about 49 percent of the brokers reported damage during storage (Table 2.24). Maize is extremely susceptible to pest damage by weevils during storage. The 51 percent who did not experience any incidence of damage were mainly traders of *teff*, the crop least susceptible to storage pests.

Table 2.23: Brokers' opinion about the quality of storage and rental charges

Quality of storage	Number	%
Adequate or average	48	82.8
Poor	10	17.2
Rental charges		
Expensive	34	56.7
Fair	25	41.7
Cheap	1	1.7

Source: Survey, 2002.

Table 2.24: Incidence of damage in storage

Response	Number	%
Yes	19	48.7
No	20	51.3
Total	39	100.0

Source: Survey, 2002.

In general, there is a very limited effort to store and sell grain during the lean months. Brokers resort to short-term storage only when they are unable to sell. Regional traders often end up losing money if the grain is not sold directly from the truck and must be unloaded, stored, and loaded for sale at a later date. With too few wholesalers or speculators with sufficient capital to store, the search for buyers is intense and downward pressure on prices is unavoidable, especially at harvest time when there is surplus supply in the market. Lack of adequate storage facilities and high storage charges, in addition to the limited number of wholesalers or speculators, explains why brokers resort to credit sales to dispose of unsold grain. Continuous price decline in recent years has also rendered storage activities unprofitable. Intervention is required to improve storage facilities and develop the credit market in order to encourage wholesale and temporal arbitrage.

2.3.3. Access to credit

Brokers' access to credit from formal banks is highly limited: 94 percent of the sampled brokers reported that they had not borrowed money from formal banks in the preceding 12 months (Table 2.25). The high collateral requirement is the major constraint to accessing finance from formal sources. Informal sources of finance are also limited: only about 36 percent of the brokers used such sources (e.g., borrowing from friends and relatives) to run their business. Use of own finance is essentially the only means to conduct brokerage and other activities. Many of the sampled brokers are members of *iqubs* (rotating saving and credit associations, ROSCAs), and each broker deposits, on average, birr 276.4 per week, with an average total *iqub* value of birr 28,342.90.

Table 2.25: Access to credit brokerage

	Formal sources		Informal sources	
	Number	%	Number	%
Yes	4	6.0	24	35.8
No	63	94.0	43	64.2
Total	**67**	**100.00**	**67**	**100.00**

Source: Survey, 2002.

2.4. Regulatory framework and contract enforcement

2.4.1. Licensing

About 72 and 42 percent of the sampled brokers have licenses for grain trade from the Trade and Industry Bureau and the Municipality of Addis Ababa, respectively. The average cost of obtaining and renewing a license was birr 563 and birr 241, respectively. About 28 percent of the brokers operate without a license. There is practically no benefit, incentive, or legal pressure to hold a license (Annex Table 2.25). Licensed brokers complained that government services in the area of transport facilities, access to parking, security services, and support of the traders' association have not shown any improvement; despite the fees they are paying (Table 2.27). It is only in the telecommunications sector that some improvements had been observed over the preceding couple of years. The implication is that brokers see no benefit in paying taxes or incurring the cost of a license.

Table: 2.26: License from government offices

	Yes	No	Total
Bureau of Trade and Industry			
Number	48	19	67
%	(71.6%)	(28.4%)	(100.0%)
Municipality			
Number	28	39	67
%	(41.8%)	(58.2%)	(100.0%)

Source: Survey, 2002.

Table 2.27: Respondents' opinion about government support

Area of government support	Improved	No improvement
Transport facilities and access	16.4%	83.6%
Telephone and other communication services	46.3%	53.7%
Security and legal services	16.4%	83.6%
Support for traders' association	7.5%	92.5%

Source: Survey, 2002.

Brokers also claimed that the level of taxation is high. About 95 percent reported that the rate of taxation is extremely high and discourages grain trade (Annex Table 2.26). In addition, the method of tax assessment was viewed as unfair (Annex Table 2.27).

2.4.2. Dispute settlement

As already described, grain trade involves credit transactions, and disputes over payment are common. Disputes may also arise over quantity, quality, and prices between a regional trader and a broker or between a broker and a buyer. Since there is no written agreement, it is difficult to enforce payment through the court system. The most common ways of settling disputes are peer pressure (69 percent) and personal effort (40 percent). About 85 percent of the sampled brokers reported that disputes are not resolved (Table 2.28). Brokers appear to operate with no legal protection and virtually no recourse to courts. The trading environment is extremely risky for brokers and regional traders. Consequently, there is very limited chance for the market to grow beyond cash-based spot markets or the physical cash market.

Table 2.28: Means of settling disputes with clients

Means	Yes	No	Total
Keble courts	2 (3.8%)	50 (96.2%)	52
Woreda and higher courts	5 (9.6%)	47 (90.4%)	52
Association arbitration	2 (3.8%)	50 (96.2%)	52
Community mediation	5 (9.6%)	47 (90.4%)	52
Friends and peers	36 (69.2%)	16 (30.8%)	52
Religious fathers	5 (9.6%)	47 (90.4%)	52
Personal effort without any arbitration	21 (40.4%)	31 (59.6%)	52
No resolution	44 (84.6%)	8 (15.4%)	52

Source: Survey, 2002.

It has been reported that grain purchasers face security problems in visiting the central market. They are often surrounded by gangsters acting as brokers and facilitators. Innocent and uninformed buyers are cheated into buying very low quality grain at very high prices from collaborators. There are no effective police forces to protect the public from such criminals. Brokers and traders reported that they have frequently complained about the problem to government offices, but to no avail. Indeed, the problem is getting out of control as increasing numbers of unemployed youth have found the crowded central market convenient for all kinds of criminal activities.

2.4.3. Membership in associations

One way to deal with the weak regulatory framework is to establish associations and increase brokers' stock of social capital. Collective action could overcome some of the weaknesses in government services. Nonetheless, the majority of brokers (73 percent) are not members of any type of trade association (either the Grain Traders' Association or the Chamber of Commerce) (Table 2.29). It appears that the associations are not providing effective services, and hence most brokers do not see the need for joining them. About 78 percent of the sample brokers belonging to the associations revealed that they are disappointed with the services provided.

Table 2.29: Membership in trade association and level of satisfaction

	Yes	No	Total
Membership			
Number	18	49	67
%	26.9	73.1	100.0
Levels of satisfaction for members			
Number	4	14	18
%	22.2	77.8	100.0

Source: Survey, 2002.

2.5. Barriers to entry and major problems faced

Many institutional and technical problems hinder traders from entering the grain market. Shortage of capital (90 percent), high cost of rent (81 percent), lack of access to stalls (76 percent), and high levels of taxation (75 percent) are the main constraints to entry into the brokerage business (Table 2.30). Since the central market facilities have not expanded in more than four decades and they are owned by the government, a new broker cannot easily access a stall. The only option is renting from original owners at high rates or working in partnership with a broker who has a stall. As a result of these and related problems, informal trade seems to have expanded, and many traders are reported to have returned their licenses to do the same business informally.[4]

Table: 2.30: Major barriers to entering brokerage business

Barrier	Yes	No
Lack of access to stall	76%	24%
Shortage of working capital	90%	10%
High cost of renting stall	81%	19%
High level of taxation	75%	25%
Difficulty in processing license	37%	63%
Lack of contact and trust with regional traders	39%	61%

Source: Survey, 2002.

The sample brokers were also asked to rank the problems of the central market on a four-point scale: (1) no obstacle, (2) minor obstacle, (3) major obstacle, and (4) very severe obstacle. The mean scores of major marketing problems are given in Table 2.31. On the basis of the mean scores, the major problems of grain marketing at the central market include expensive rent for stalls, lack of access to operating premises, high tax rate, congestion at the marketplace, and poor tax administration. There is a need for government intervention to correct these deficiencies and create an enabling environment for brokers.

Table 2.31: Mean score of major marketing problems

Problem	Extent of obstacle
Poor telecommunications	1.96
Lack of electricity	1.48
Lack of transportation	1.84
Poor access to operating place	2.96
High tax rates	2.70
Poor tax administration	2.54
Lack of standards	1.73
Unlicensed operators	2.45
Weak legal system for contract enforcement	1.88
Congestion at marketplace	2.58
Expensive stall rent	3.39
Long procedures for licensing and registration	1.73
Limited access to credit	2.13
Crime, theft, disorder and lack of trust	1.96
Anticompetitive practices	1.64
Weak access to market information	1.43

Source: Own computation.

3. GRAIN RETAILERS

Retailers serve as intermediaries between consumers on the one hand and regional traders, wholesalers, and producers on the other hand. The central market is devoted to retailing activities every day between 9:00 a.m. and 6:00 p.m. Grain bought from retailers is often transported to its destination by donkeys.

About 76 percent and 24 percent of the sample retailing enterprises were owned and operated by men and women, respectively (Annex Table 3.2). A significant proportion of the retailers have been established since 1991 (Table 3.1). Private retailing activities were very much limited between 1975 and 1991, when private business was actively discouraged by the government then in power.

Table 3.1: Year of establishment

Year	Number of retailers	%
Before 1974	7	6.6
1975–81	22	20.8
Since 1991	77	72.6
Total	107	100.00

Source: Survey, 2002.

Retailers were also asked how they started their business. A high percentage of retailers, about 85 percent, established their own business, while 9 percent inherited it from their parents and relatives.

The average capital required to start the business was about birr 7,387. As for brokerage businesses, the main sources of initial capital were internally generated funds followed by borrowing from relatives and friends (Table 3.2). Small businessowners such as retailers cannot access bank loans as they lack valuable assets for collateral purposes.

Table 3.2: How was the business started?

Response	Number	%
Set it up/established it	91	85.0
Inherited	10	9.3
Bought	1	3.7
Do not know	2	1.9
Total	107	100.0

Source: Survey, 2002.

Almost 33 percent of the sample retailers perform their activities from premises rented from the government. The average area of the stall is 36 square meters. Another 50 percent conduct their business in space rented from private individuals (Table 3.3).

Table 3.3: Ownership of the premises

Response	Number	%
Own	19	17.8
Rent from government	35	32.7
Rent from private individual	53	49.5
Total	107	100.0

Source: Survey, 2002.

A few retailers (11 out of 107 or 10 percent) are also involved in other activities, such as merchandise trade and flourmills. Only one retailer operates a small flourmill. Limited capital is believed to discourage diversification into various activities.

Only 24 percent of the workers in the sample retail establishments have completed secondary school. The majority of the workers (96 percent) had not received any training related to their business in the preceding three years.

3.1. Operation of grain retailers

Ninety-eight percent of retailers get their grain supplies from the central market. Some purchase directly from farmers (18 percent) and others from nearby rural markets (15 percent) (Table 3.4). Purchases at the central market are carried out through brokers or through direct contact with truck owners. Retailers often go to any broker in the market, implying no established client relationship. Only 24 percent have brokers who regularly assist them in purchasing (Table 3.5).

Table 3.4: Place of grain purchase for retailing

Place of grain purchase	Yes	No
Directly from farmers	19 (17.8%)	88 (82.2%)
From rural markets	15 (15.0%)	91 (85.0%)
Central market	105 (98.1%)	2 (1.9%)

Source: Survey, 2002.

Table 3.5: Means of purchasing grain from central market

Means of purchase	Yes	No
Through brokers from trucks (no client brokers)	105 (98.1%)	2 (1.9%)
Through direct contact with truck owners	19 (17.8%)	88 (82.2%)
Through client brokers from trucks	26 (24.3%)	81 (75.7%)

Source: Survey, 2002.

Like brokers, retailers use cash or credit sales to dispose of their stock. In recent years credit sales have become important. For instance, about 40–59 percent of *teff w*as sold on credit during the month of February 2002. The figures for wheat and maize ranged from 29 to 36 percent and 29 to 32 percent, respectively (Table 3.6).

Table: 3.6: Mode of sale for most recent sale

	% of sales via	
Crop type	Cash	Credit
Adda teff	60.4	39.6
Wollenkomi teff	57.0	43.0
Gojjam/Bechena teff	40.9	59.1
Wheat, grade 1	70.7	29.3
Wheat, grade 2	64.2	35.8
Wheat, grade 3	68.0	32.0
Maize, white	70.2	29.8
Maize, mixed	67.8	32.2

Source: Own computation.

As already noted, credit sales to customers involve risk in the sense that debtors may refuse to pay back. About 79 percent of the retailers reported losing money in the preceding three years as a result of defaulting customers (Table 3.7). On average, retailers lost birr 1,722.3 over the preceding three years. Retailers did not take defaulters to court, mainly because they had no written agreement. Other reasons included unknown address (23 percent), delays in court decision (15 percent), and lack of money and time (11 percent) (Table 3.8).

Table: 3.7: Money lost due to credit sales and defaulters over the last three years?

Response	Number	%
Yes	84	78.5
No	23	22.5
Total	107	100.00

Source: Survey, 2002.

Table 3.8: Reasons for not taking defaulters to court

Reason	Number	%
Unknown address	17	22.7
Delays in the court decision	11	14.7
No written evidence	28	37.3
Lack of money and time	8	10.7
Fear of social sanction	4	5.3
Others	1	1.3

Source: Survey, 2002.

Purchase price is subject to negotiations for retailers. Of the sample retailers, about 43 percent reported that they bargain and get lower prices. Negotiation skills are very important in the absence of a single market-clearing price.

The main types of buyers that commonly purchase grain from retailers include salaried people (88.8 percent), low-income informal sector workers (67.3 percent), bread *(enjera)* sellers (49.5 percent), and small restaurants (29.9 percent) (Table 3.9). These buyers are regular clients and visit retailers every week, every two weeks, or every month (Table 3.10). The quantity of grain purchased is less than 100 kilograms in most cases.

Table 3.9: Types of buyers who frequently visit retailers' stalls

Buyer type	Yes	No
Salaried people	95 (88.8%)	12 (11.2%)
Small restaurants	32 (29.9%)	75 (70.1%)
Bread *(enjera)* sellers	53 (49.5%)	54 (50.5%)
Informal sector workers	72 (67.3%)	35 (32.7%)
Medium- and high-income business owners	28 (27.5%)	74 (72.5%)

Source: Survey, 2002.

Table 3.10: Most commonly observed buyers and frequency of purchase

Type of buyer	Weekly	Monthly	Bimonthly	Every two months
Salaried people	1 (1.1%)	91 (95.8%)	1 (1.1%)	1 (1.1%)
Salaried people	1 (1.1%)	91 (95.8%)	1 (1.1%)	1 (1.1%)
Small restaurants	17 (51.5%)	2 (6.1%)	7 (21.2%)	
Bread (*enjera*) sellers	31 (59.6%)	1 (1.9%)	13 (25.0%)	1 (1.9%)
Low-income informal sector workers	22 (32.8%)	11 (16.4%)	23 (34.3%)	6 (9.0%)
Medium- and high-income business owners	1 (3.3%)	17 (56.7%)	2 (6.7%)	8 (26.7%)

Source: Survey, 2002.

Retailers reported that most buyers (about 72 percent) come with adequate information about the prevailing market prices. Specifically, 62 percent of salaried people, 82 percent of small restaurants, 79 percent of bread sellers, and 77 percent of informal sector workers were reported to have adequate information about prevailing market prices (Table 3.11). It is common to check the prices of two or more sellers before making a purchase decision. This information enables buyers to bargain for lower prices.

Table 3.11: Buyers' information about grain prices

Buyer type	Most come with adequate information	Most come with limited information	Most come with no information
Salaried people	59 (62.1%)	33 (34.7%)	3 (3.2%)
Small restaurants	28(82.4%)	6 (17.6%)	0
Bread *(Enjera)* sellers	42 (79.2%)	10 (18.9%)	1 (1.9%)
Low income informal sector workers	52 (76.5%)	14 (20.6%)	2 (2.9%)
Medium and high income business owners	20(69.0%)	6 (20.7%)	3 (10.3%)

Source: Survey, 2002.

It is also observed that buyers react differently under conditions of high grain prices. They may reduce the quantity of their purchase or switch from higher to lower grade grains (Table 3.12). Sellers are often pressurized to lower prices unless there is a series shortage of supply in the market.

Table 3.12: Buyers' response to higher grain prices

Response	Yes	No
Mix lower grades with higher grades	25 (23.4%)	82(76.6%)
Reduce quantity purchased	91 (85.0%)	16 (15.0%)
Switch from higher to lower grades	80 (74.8%)	27 (25.2%)
Accept the given price	7 (100%)	0
Ask for credit sales	13 (1005%)	0

Source: Survey, 2002.

3.2. Premises and transport facilities

As already indicated, the majority of retailers (about 76 percent) do not have their own premises (Annex Table 3.4). They depend on rented premises. Retailers pay, on average, birr 462 and 567 for government-owned and private-owned premises per month, respectively (Annex Table 3.5). 5 The average capacity of each facility was only 203 quintals. In terms of quality, about 74 percent reported that their premise is a proper stall with a locker, whereas 26 percent reported that they use only simple shades (Annex Table 3.6). None of the sample retailers own trucks or personal automobiles (Annex Table 3.7).

5 Renting storage from individuals is more expensive than renting from government.

3.3. Access to credit (working capital)

The majority of the sample retailers (94 percent) had not borrowed money from formal banks in the preceding 12 months. Informal sources are the only means to finance retail activities (Table 3.13). On average, the retailers had borrowed birr 4,403 during the preceding 12 months. About 35 percent are members of *iqub,* and each deposits birr 145 per week on average. The average total value of deposits is birr 9,354, compared with birr 28,342.90 in the case of brokers (Annex Table 3.8).

Table 3.13: Credit facilities for retailing activities

	Formal sources		Informal sources	
Response	Number	%	Number	%
Yes	6	5.6	35	32.7
No	101	94.4	72	67.3
Total	107	100.00	107	100.00

Source: Survey, 2002.

3.4. Regulatory framework and policy

About 68 percent of the sampled retailers have a license from the Trade and Industry Bureau of Addis Ababa (Annex Table 3.9). The average cost of obtaining and renewing a license was birr 182 and birr 119, respectively. On the other hand, 32 percent of retailers do not have a license because they do not have premises and adequate capital. Obtaining a license requires, among other things, having a stall and initial capital (usually more than birr 5,000). Because of the weak regulatory and legal environment, retailers have no strong pressure to get a license. Licensed retailers complain that they incur the additional cost of taxes and other government charges while their competitors operate freely.

Licenses are expected to provide the licensee access to government services and protection from unfair trading practices. Almost all of the sample retailers reported, however, that public services in terms of transport facilities, access to parking, security services, and support of the traders' association are weak and not improved over time (Table 3.14). They felt that the government ought to ensure a level playing field and improve public services.

Table 3.14: Retailers' views of government support

Area of government support	Improved	No improvement
Transport facilities and access	9.3%	90.7%
Telephone and other communication services	35.5%	64.5%
Security and legal services	15.0%	85.0%
Support for traders' association	10.3%	89.7%

Source: Survey, 2002.

Retailers were also asked about the level of taxation. The majority (about 91 percent) claimed that the level of taxation is high. The method of tax assessment is also considered unfair because it is not based on sales income. The method of tax administration and assessment leaves much to be desired (Table 3.15).

Table 3.15: Retailers' views of the level of taxation and tax assessment

Tax levels	Number	%
High	72	91.1
Average	7	8.9
Total	79	100.00
Assessment		
Not based on income	61	80.3
Needs improvement	3	3.9
Not reasonable	7	9.2

Source: Survey, 2002.

3.5. Barriers to entry and major problems

A number of institutional and technical problems have hindered traders' freedom to engage in grain trade. Lack of access to stalls, a shortage of working capital, high taxes, and lack of contact and trust with regional traders are among the major problems (Table 3.16).

Table 3.16: Major problems for entry into retail business

Type of problem	Yes	No
Lack of access to stall	62.6%	37.4%
Shortage of working capital	89.9%	10.1%
High renting cost of stall	73.8%	16.2%
High level of taxation	72.9%	26.1%
Difficulty in processing license	37%	63%
Lack of skill	40.2%	59.8%

Source: Survey, 2002.

A number of problems undermine the efficient operation of the retail market. The sample retailers were asked to rank the problems of the retail market on a four-point scale: (1) no obstacle, (2) minor obstacle, (3) moderate obstacle, and (4) very severe obstacle. High tax rates, expensive stall rent, unlicensed operators, lack of access to operating premises, and problems in tax administration were the major constraints identified (Table 3.17). These problems were also reported by flour factories and trading companies.

Table 3.17: Mean score of major problems in retail market

Obstacle	Extent of obstacle
Poor telecommunications	1.80
Lack of electricity	1.77
Lack of transportation	1.96
Poor access to operating place	2.53
High tax rates	2.86
Poor tax administration	2.69
Lack of standards	1.60
Unlicensed operators	2.69
Weak legal system for contract enforcement	2.00
Congestion at marketplace	2.51
Expensive stall rent	3.12
Long procedures for license and registration	1.73
Limited access to credit	2.28
Crime, theft, disorder, and lack of trust	1.81
Anticompetitive practices	1.64
Weak access to market information	1.98

Source: Own computation.

Limited capital, inadequate human resources, a weak regulatory framework, poor infrastructure, and other factors have also constrained the operation of retailers. They were unable to improve the retail market by expanding into milling and packing. Operators of flourmills (not included in this survey), however, have increasingly expanded their activities to include retailing milled *teff* to their customers.

Inefficiencies in the retail sector have also caused difficulties for consumers. A group discussion with consumers revealed that lack of reliable information about the quality and price of grain is a major constraint in the retail market. Households have two options in buying *teff*: buy unmilled grain from retailers and get it milled at flourmills or buy milled product from owners of flour mills. Consumers are certainly better off if they can buy milled *teff*, but they have difficulty knowing the exact quality and grade of milled *teff* as visual inspection is less precise in the case of milled grain. For the most part, they can only depend on what mill operators tell them.

There is widespread mistrust, however, of operators at the central market. Consumers generally perceive the quality of *teff* or other grain they bought as poorer than what they were told or led to believe. In particular, the extent of impurities or unwanted type or grade can be high if the seller or intermediary is not a trusted client. In addition, there is little protection against traders using inappropriate scales.

Getting reliable price information is one of the other most difficult aspects of the retail market. Consumers who do not have time to go around the central market and check are likely to face higher prices. Uninformed buyers are often met by gangs acting as intermediaries and can be easily cheated. Having a trusted client is often the only protection against overcharging and cheating.

4. REGIONAL TRADERS

Regional traders buy grain from farmers and supply the central market. The effects of trade liberalization on producers can be examined through its impact on regional traders. This section examines how regional traders operate and how they interact with brokers at the central market of Addis Ababa.

Almost all sample respondents are male traders, and the majority are owner-managers. The majority of regional traders started their business after the 1991 reform. A vast majority of the traders, 87.5 percent, established their own business, while 6.3 percent inherited the business from their parents and relatives (Table 4.1).

Table 4.1: How was the business started?

Response	Number	%
Set it up/established it	28	87.5
Inherited	2	6.3
Bought	1	3.1
Do not know	1	3.1
Total	32	100.0

Source: Survey, 2002.

Not many regional traders reported having diversified into other business activities. Only 7 out of the 32 cases (22 percent) run merchandise trade and flourmills (Annex Table 4.2). The majority of the regional traders appear to have devoted all their resources to grain trade.

The average capital of regional traders is birr 35,906.25, and the main source of initial capital is *iqub* (66 percent), followed by gift from family (9 percent) and borrowing from relatives and friends (9 percent). Unlike the brokers and most of the retailers in Addis Ababa, regional traders need a large amount of capital to buy grain in cash and transport it to Addis Ababa. Only two of the sample respondents managed to get loans from formal financial institutions (Table 4.2).

Table 4.2: Sources of initial capital

Source	Number	%
Gift from family	3	9.4
Bank loan	2	6.3
Borrowed from relatives and friends	3	9.4
Iqub	21	65.6

Source: Survey, 2002.

4.1. Prices and transport charges

Operating without a broker would require regional traders to travel to Addis Ababa and search for buyers by themselves at the central market. Consequently, more than 90 percent of the sample traders have client brokers at the Addis Ababa central grain market. Regional traders reported establishing initial contact with brokers at Addis Ababa through friends (59 percent) and personal contacts (53 percent). Others are approached by the brokers themselves (53 percent) (Table 4.3).

Table 4.3: How was the initial contact with a broker established?

Response	Yes	No	Total
Approached by the broker himself	17 (53.1%)	15 (46.9)	32
Approached myself	14 (43.8%)	18 (56.2%)	32
Through friends	19 (59.4%)	13 (40.6)	32

Source: Survey, 2002.

Regional traders consider a number of factors, including purchase price, handling costs, demand, and quality of grain, in proposing sales prices at the central market in Addis. Purchase prices and trading costs are obviously the most important factors influencing selling prices (Table 4.4), but grain is sold at what the central market offers. Hence, many regional traders (about 87 percent) reported consulting brokers to get information about prices in Addis in order to set a price at which they have to buy from farmers. Unfortunately, not many regional traders have access to telephone or other means of communication to get market information on a regular basis.

Table 4.4: How do you set a sales price?

Method	Number	%
Consider purchase price and other costs	22	73.3
Depend on quality of grain and number of buyers at Addis Ababa	3	10.0
Depend on demand and supply (including season)	5	16.7

Source: Survey, 2002.

Only about 53 percent of the regional traders get price information in Addis Ababa via telephone. Others rely on fellow traders who sold grain recently (26.7 percent). They also get price information from transporters, who usually convey information about prices and other messages to and from regional traders (Annex Table 4.5). However, the largest number of traders get price information only once a week (29 percent) followed by the number of traders who get price information three times a week (26 percent) (Table 4.5). Lack of information is a severe constraint in the operation of regional traders.

Table 4.5: Frequency of getting price information

Frequency	%
Daily	22.6
Weekly	29.0
Three times per week	25.8
Twice per week	9.7
Twice per month	9.7
Four times per month	3.2

Source: Own computation.

Transport charges are high and vary from season to season. About 47 percent of traders consider transport charges high, whereas half of them perceived the charges as average. But transporters claim that the charges are low and that hence the transport business is not profitable. Poor road conditions and the lack of a return load has increased the cost of providing effective and low-cost transport services.

The results show that, like brokers and retailers, regional traders operate with a low asset base and limited capital (both human and physical). They are also constrained by poor access to finance, which limits their business activities. Credit from formal financial sources remains out of the reach of many regional traders. Getting information on the quantity, quality, and price of grain on a regular basis is also a problem as there is no organized system to provide market information.

4.2. Regulatory framework and marketing constraints

Regional traders were asked whether they have licenses from the relevant authorities. About 81 percent of the respondents have a license from the Trade and Industry Bureau. The average costs of obtaining and renewing a license were birr 186 and birr 82, respectively. About 19 percent of the regional traders have no license. About a third of the respondents are not satisfied with the service provided by the relevant government authorities. Like the retailers, many regional traders reported that government services in the area of transport facilities, access to parking, security and legal services, and support of traders' associations are weak and have not shown improvement over time (Table 4.6). More than 80 percent of the regional traders also reported that the current tax rate is high (Annex Table 4.6).

Table 4.6: Regional traders' opinion about government services

Areas of government support	Improved	No improvement
Transport facilities and access	18.8%	81.3%
Telephone and other communication services	25.0%	75.0%
Security and legal services	12.5%	87.5%
Support for traders' associations	0%	100.0%

Source: Survey, 2002.

As already noted, brokers in Addis Ababa often sell on a credit basis. The majority of regional traders (63 percent) have faced cash shortages because it takes time for grain to be sold and the money to be sent back to them (Annex Table 4.8). Some were forced to make no purchases or reduce purchases owing to cash shortages (Annex Table 4.9).

Another serious problem faced by regional traders is credit sales. For example, about 41 percent of regional traders had experienced disputes with their client brokers over payments that involved credit sales during the preceding three years. Regional traders reported having lost on average birr 2,779 as a result of default. About 85 percent of the respondents affected said that they did nothing to get their money back. Peer pressure is used, but it does not seem to be very effective since regional traders do not have direct contact with the buyers in Addis Ababa (Table 4.7). There is no way for the grain market to develop and expand as long as the legal and regulatory framework provides no protection to exchange transactions.

Table 4.7: Means of settling disputes with clients

Means	Yes	No
Keble courts	0 (0%)	13 (100%)
Arbitration through association	1 (7.7%)	12 (92.3%)
Community mediation	2 (15.4%)	11 (84.6%)
Friends and peers	8 (61.5%)	5 (38.5%)
Religious elders	2 (15.4%)	11 (84.6%)
Personal effort (e.g., repeated visit)	5 (38.5%)	8 (61.5%)
No effort of any kind	11 (84.6%)	2 (15.4%)

Source: Survey, 2002.

Regional traders have identified the main limiting factors as problems with communication, checkpoints on the roads, too many unlicensed operators, high tax rates, crime, theft, and lack of trust (Table 4.8). Regional trade is also severely constrained by lack of telecommunication services. High tax rate and poor methods of tax assessment have been reported as the main problems by brokers, retailers, regional traders, transporters, flour factories, and trading companies alike.

Table 4.8: Mean score of major marketing problems for regional traders

Description	Extent of obstacle
Lack of telecommunications	2.53
Lack of electricity	2.16
Shortage of storage in Addis Ababa	2.38
Lack of vehicles and trucks	2.19
Stoppage time at different *kellas*	2.56
Poor access to operating place	2.53
High tax rates	3.38
Poor tax administration	3.13
Lack of standards	1.53
Unlicensed operators	2.58
Weak legal system for contract enforcement	1.69
Congestion at marketplace	2.66
Expensive stall rent	3.12
Long procedures for license and registration	1.63
Limited access to credit	2.38
Crime, theft, disorder, and lack of trust	2.75
Anticompetitive practices	2.22
Weak access to market information	2.03

Source: Own computation.

The system of grain trading does not involve organized large-scale wholesalers who buy from regional traders, except in limited cases. Regional traders would face less difficulty finding buyers if there were wholesalers who could buy grain from them at an agreed or negotiated price. Transport costs would have been lower because trucks would not have to wait until a buyer was found. There would be no reason for overcrowding and distress sales. Wholesalers serve as middlemen between regional traders and distributors (retailers or other wholesalers). They assemble and sort grain based on grades and standards. Since they own large-scale storage facilities, they can help avoid or reduce gluts in the market during peak periods. The fact that such an important class is not very strong in the market chain, with the exception of the few that operate largely outside the central market system (see section 6), has reduced the efficiency of the market. Lack of capital and weakness in the regulatory system that should provide grading and standardization services and ensure specialized services such as wholesaling and retailing are among the major reasons for the poor organizational structure of the market.

5. PRICE TRENDS AND ADJUSTMENT AT ADDIS ABABA CENTRAL MARKET

Collecting price information is a difficult venture in a situation where there are no formal standards and grades and where informal grades and standards are numerous and subjectively established. Different grades must be lumped together to arrive at an average price, but such a price is of little value to the different actors. This means that price information is of little value. Moreover, prices decline later during the market day because high-quality grains are sold early in the morning and what is leftover is often viewed as lower in quality. This chapter examines price adjustment, taking into account these limitations.

Cereal prices have fallen dramatically since March 2000 and remain significantly below historical levels in all major markets of the country. Price trends between March 2000 and March 2002 were very worrisome, particularly for maize, with producer prices often falling below cost of production in many areas. A significant decline in farm input utilization was reported for the 2001/02 *meher* (main) production season.

Brokers were asked about the trend in supply of and demand for grain. About 60 percent reported that supply to the central market had been decreasing over time owing to lack of demand and declining prices. Brokers also said that grain production in 2002 was greater than in the previous year but that demand was lower than in the previous year, leading to a fall in grain prices in 2001 and 2002. This situation can be attributed to declining per capita income and worsening poverty, especially in urban areas.[6] This has adversely affected both traders and farmers in the country.

5.1. Time series analysis

Because one of the aims of the study was to examine the behavior of prices in a given market, daily market prices of *teff*, wheat, and maize were recorded at three different times of the day: opening, or 6:00 a.m.; halfway through the market day, or 7:30 a.m.; and closing, or 9:00

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[6] See for instance, FDRE, Ministry of Finance and Economic Development (MOFED), Sustainable Poverty Reduction Strategy Program (SPRSP), 2002

a.m. The survey included wholesale and retail prices during the period spanning March to July 2002.

5.1.1. Trends in wholesale prices

Grain prices vary significantly by origin and grades. Consider, for example, the average price of the different grades of wheat for the month of March 2002. The price of grade 1 was birr 96.3 per quintal, compared with birr 90.8 and 83.1 for grades 2 and 3, respectively. In the case of *teff*, *Adda teff*, the best quality, fetched the highest price (on average birr 212.1 per quintal in March 2002). The prices for *Wollenkomi* and Gojjam/*Bechena* were birr 158.5 and 134.1, respectively in March 2002 (Table 5.1). But prices varied by grade within each type of *teff*. For instance, the three grades of *Adda teff*, grades 1, 2 and 3, were sold on April 14, 2002, at an average price of birr 230, 205, and 185 per quintal, respectively. Prices also varied by hour in a given market day. Buyers may have to decide what time of the day (between 6 and 9 a.m.) to enter the market.

Table 5.1: Quality-based differences in wholesale grain prices, March 2002 (average price in birr/quintal)

Grain	Average price for month	Price variation by hour 6:00	7:30	8:30
Wheat type by grade				
Grade 1	96.3	96.8	96.3	95.8
Grade 2	90.8	89.6	91.1	90.0
Grade 3	83.1	80.6	83.6	82.1
Teff type by origin				
Adda	212.1	214.0	213.0	210.7
Wollenkomi	158.5	160.1	158.8	157.2
Gojjam/*Bechena*	134.1	135.6	134.4	132.7

(a) Price variability

To assess wholesale price instability at the central market, we used a trend-adjusted coefficient of variation (Kherallah et al. 2000).[7] As shown in Table 5.2, the average wholesale prices of *Adda teff*, *Wollenkomi teff*, and Gojjam/*Bechena teff* at market opening time were, respectively, birr 221.1, 176.2, and 156.1, while the figures for market closing time were birr 219.5, 174.3, and 154.9, respectively. Prices have tended to decline toward market closing time in nearly all cases.

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[7] The instability index (II) is given by: $II = CV\sqrt{(1 - R^2)}$ where *CV* is the coefficient of variation and R^2 is the coefficient of determination of the linear trend regression.

The average wholesale price of all *teff* types showed a sharp increase toward the end of April, mainly because of government intervention in the grain market. Wholesale prices of *teff* stablized afterward but at higher level. Table 5.2 reveals that the opening prices of *Adda, Wollenkomi,* and Gojjam/*Bechena* are less volatile than the closing prices. A higher degree of instability has been observed between the opening and closing period of the market (i.e., around 7:30 a.m.): a higher standard deviation, indicating significant variability. An interesting feature of *teff* prices is that instability index tends to decline during the closing period of the market. Prices also tend to be less stable or become more variable at closing time.

Table 5.2: Instability index of daily wholesale prices of *teff,* March–July 2002

	Adda			*Wollenkomi*			Gojjam/Bechena		
Description	6:00	7:30	8:30	6:00	7:30	8:30	6:00	7:30	8:30
Mean price	221.13	221.41	219.53	176.16	180.16	174.3	156.43	156.52	154.93
SD	10.59	11.29	12.68	17.15	20.3	17.38	19	20.41	19.35
Instability index	4.56	4.84	5.49	7.24	10.16	7.41	5.58	7.91	6.40

Source: Own computation.

The average opening prices of wheat grades 1, 2, and 3 were birr 121.6, 117.2, and 111.3, respectively, during the period under consideration. The corresponding closing prices were 121.3, 116.7, and 110.8 (Table 5.3). It has been observed that, except on a few market days, the closing wholesale prices of all wheat types were consistently lower than the opening or midway prices. This is similar to *teff,* and it can be attributed to the fact that as 9:00 a.m. approaches brokers make every effort to sell their wheat and offer lower prices. Failure to sell on any given day implies additional parking costs, and transporters lose the opportunity of moving to other businesses. In addition to the storage costs, regional traders will not get their money (sales revenue) if the grain is not sold within the three market days.

Similar to *teff* types, the opening prices of all wheat types were less volatile than the closing price. Relatively higher instability has been observed for all wheat types during the middle hour of the market day. The instability index tends to increase during the closing period of the market, compared with the opening price.

It should also be noted that there seems to be some relationship between the degree of price instability and the quality of wheat. Table 5.3 shows that the higher the quality, the lower the instability index. For instance, of the three wheat grades, wheat grade 1 has the lowest price instability index. The pattern is the same for *teff*, with the lowest instability index reported in the case of *Adda teff*. It pays farmers to produce the highest possible quality of grain to get a more predictable price.

Table 5.3: Instability index of daily wholesale prices of wheat, March–July 2002

	Wheat grade 1			Wheat grade 2			Wheat grade 3		
Description	6:00	7:30	8:30	6:00	7:30	8:30	6:00	7:30	8:30
Mean price	121.6	121.7	121.3	117.2	117.4	116.7	111.3	111.8	110.8
SD	24.9	25.1	25.2	25.2	24.8	25.1	28.8	27.6	27.8
Instability index	14.19	14.93	14.55	15.52	15.90	15.76	19.91	19.51	19.63

Source: Own computation.

With regard to maize, the mean opening prices were birr 69.8 for white maize and birr 65.9 for mixed maize over the same period. The average closing prices were slightly lower, at birr 69.3 for white and 65.2 for mixed during the period under review (Table 5.4).

The coefficients of variation of the price of maize were relatively high, suggesting substantial fluctuations during the period under consideration (Table 5.3). Both the magnitudes of standard deviation and instability indexes were relatively high, an indication of substantial price variability compared with other crop types. This may be attributed to the fact that maize cannot be stored beyond June without significant damage by weevils. Maize is also an inferior crop, and its consumption is inversely related to the price of *teff*. There is less preference for maize immediately after the harvest but high preference during the lean season. It should also be noted that the closing price index was consistently higher than the beginning price index, whereas the price index during the middle hour of the market was the highest.

Table 5.4: Instability index of daily wholesale prices of maize, March–July 2002

	White maize			Mixed maize		
Description	6:00	7:30	8:30	6:00	7:30	8:30
Mean price	69.8	69.9	69.3	65.9	65.9	65.2
SD	19.2	19.3	19.1	18.7	19.0	18.9
Instability index	26.19	26.16	26.20	21.06	25.92	21.50

Source: Own computation.

(b) Seasonal movements of wholesale prices

Because of seasonality factors, crop prices behave in a relatively predictable manner during a given production year. The main driving force of seasonality is the "on-off" nature of crop harvest—that is, the fluctuations in supply, demand, and marketing (Wolday 1994). For instance, in Ethiopia supply of crops increases from December to March, which is harvest season, and it declines thereafter until the next harvest time. The former is called the "harvest lows", referring to the effect of high supply on prices and the latter is the "postharvest rally."

Seasonality in supply and marketing are the main features of agricultural products in Ethiopia. The seasonality index can capture seasonal movements of crop prices.[8] Spatial variation in wholesale prices, measured by standard deviation (SD), was lower during the postharvest periods (March) than during lean periods (after March). This implies that price stability is high when crop prices are low and vice versa (Minten 1999). Seasonal indexes of wholesale prices are lowest during the month of March and April and highest during June and July (Table 5.5–5.7).

Table 5.5: Seasonality index of wholesale price of *teff*

	Adda			*Wollenkomi*			Gojjam/Bechena		
Month	6:00	7:30	8:30	6:00	7:30	8:30	6:00	7:30	8:30
March	96.93	96.34	96.14	91.19	88.38	90.48	87.03	86.24	86.03
April	95.69	95.63	95.26	93.33	91.05	92.45	89.11	88.87	87.94
May	97.96	98.25	98.47	97.22	95.22	97.59	96.78	96.93	97.59
June	104.89	104.84	104.64	109.46	118.70	110.31	115.31	115.71	116.21
July	104.53	104.94	105.49	108.79	106.65	109.17	111.77	112.25	112.23
Minimum	95.69	95.63	95.26	91.19	88.38	90.48	87.03	86.24	86.03
Maximum	104.89	104.94	105.49	109.46	118.70	110.31	115.31	115.71	116.21
Seasonality gap	9.20	9.31	10.23	18.27	30.32	19.84	28.27	29.48	30.18
Mean	221.13	221.41	219.53	176.16	180.16	174.3	156.43	156.52	154.93
SD	10.59	11.29	12.68	17.15	20.3	17.38	19	20.41	19.35

Source: Own computation.

Table 5.6: Seasonality index of wholesale price of wheat

	Wheat grade 1			Wheat grade 2			Wheat grade 3		
Month	6:00	7:30	8:30	6:00	7:30	8:30	6:00	7:30	8:30
March	80.4	79.9	79.8	77.3	78.4	77.9	72.6	75.0	74.3
April	86.7	86.7	86.6	87.1	86.5	86.3	86.2	85.6	85.7
May	97.5	97.2	97.4	98.6	98.2	98.5	100.6	100.2	100.4
June	105.0	105.9	105.4	105.6	105.8	105.8	106.7	106.6	106.5
July	130.4	130.2	130.7	131.4	131.1	131.6	133.8	132.7	133.1
Minimum	80.4	79.9	79.8	77.3	78.4	77.9	72.6	75.0	74.3
Maximum	130.4	130.2	130.7	131.4	131.1	131.6	133.8	132.7	133.1
Seasonality gap	50.0	50.3	51.0	54.2	52.6	53.7	61.2	57.7	58.8
Mean	121.6	121.7	121.3	117.2	117.4	116.7	111.3	111.8	110.8
SD	24.9	25.1	25.2	25.2	24.8	25.1	28.8	27.6	27.8

Source: Own computation.

Table 5.7: Seasonality index of wholesale price of maize

	White maize			Mixed maize		
Month	6:00	7:30	8:30	6:00	7:30	8:30
March	72.8	72.2	72.8	72.5	71.5	71.7
April	77.7	77.8	77.3	76.3	76.6	75.7
May	86.7	86.7	86.8	86.6	86.3	86.4
June	129.3	129.3	129.7	129.3	129.8	129.5
July	133.5	134.0	133.4	135.3	135.8	136.8
Minimum	72.8	72.2	72.8	72.5	71.5	71.7
Maximum	133.5	134.0	133.4	135.3	135.8	136.8
Seasonality gap	60.8	61.7	60.7	62.8	64.3	65.1
Mean	69.8	69.9	69.3	65.9	65.9	65.2
SD	19.2	19.3	19.1	18.7	19.0	18.9

Source: Own computation.

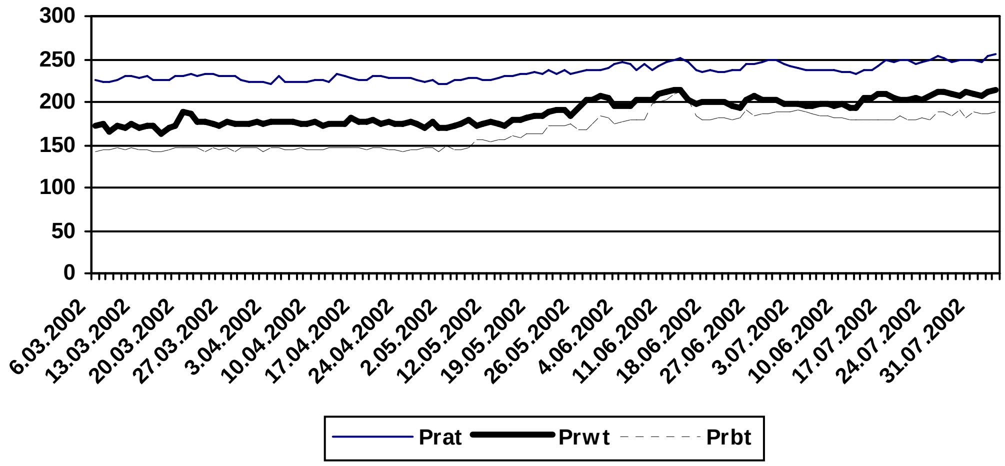
Table 5.5 shows that seasonality indexes of all types of *teff* showed an increasing trend over time. As expected, the seasonality indexes of all *teff* types were lowest during the month of March and highest during June and July. However, unlike *Adda teff*, the seasonality indexes of *Wollenkomi* and Gojjam/*Bechena teff* declined during the month of July. It should be noted that the seasonality gap of *Adda teff* (highest quality) appeared lowest and did not show significant variation during the opening and the closing period of the market.

While price indexes of wheat and maize showed an increasing trend over the period under review, maize price indexes were erratic—that is, the indexes fluctuated substantially compared with those for wheat. The seasonal effect is higher for wheat and maize than for *teff*. The relative stability of the seasonal indexes of *teff* might be due to the stronger demand in urban areas (less substitution in making *enjera*). *Teff* can also be stored without fumigation for a longer period of time than can the other crops. Of the three crops, the seasonality effect of maize seems to be highest.

5.1.2. Trends of retail prices

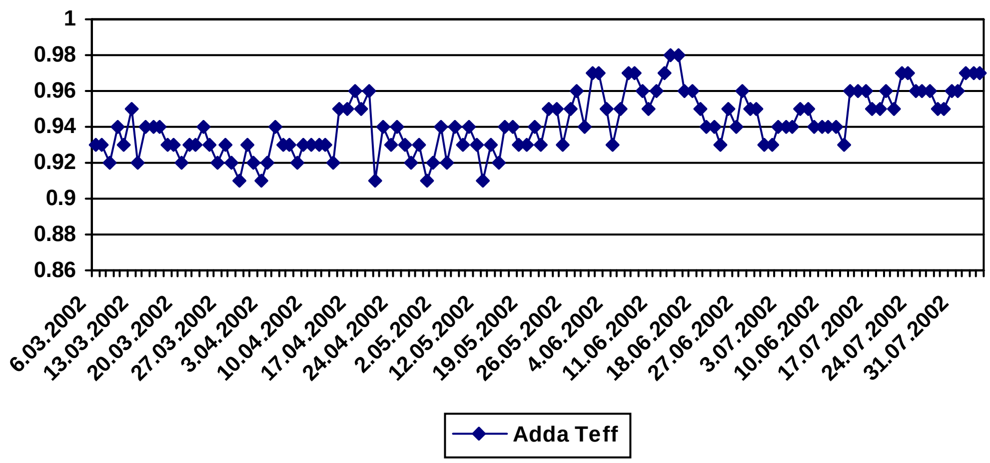
The average retail price of *teff* was consistently above the average retail prices of wheat and maize. Within *teff* types, the average daily retail price of *Adda teff* (*Prat*) is the highest (Figure 5.1). On the other hand, average daily retail price of *Bechena teff* (*Prbt*) is the lowest of all, while average daily retail price of *Wollenkomi teff* (*Prwt*) lies between the two types.

Figure 5.1: Average daily retail prices of different teff types



It is important to examine the trend of the ratio of the wholesale to retail price to gauge the magnitude of the marketing margin. The evidence shows that Ethiopian traders operate within a very small gross margin. The ratio fluctuated around 0.94, 0.95, and 0.95 for *Adda, Wollenkomi,* and Gojjam/*Bechena teff*, respectively, suggesting that retailers' price margin was not large enough (Figure 5.2). In other words, the wholesale price was not significantly different from the retail price. Whereas the trading margins of *Wollenkomi* and Gojjam/*Bechena teff* were stable, the trading margin for *Adda teff* showed volatility over time.

Figure 5.2: Ratio of wholesale to retail prices for *Adda teff*



A similar pattern was observed for wheat and maize. The difference between the wholesale price and retail price for these crops was not large. The margin for wheat grade 1 fluctuated around 0.94 and 0.92 during the period under review (Figures 5.3 and 5.4).

Figure 5.3: Ratio of wholesale to retail prices for wheat grade 1

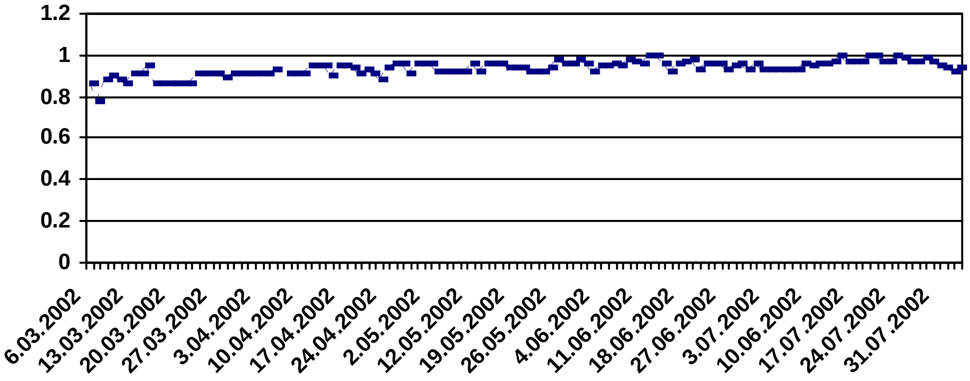
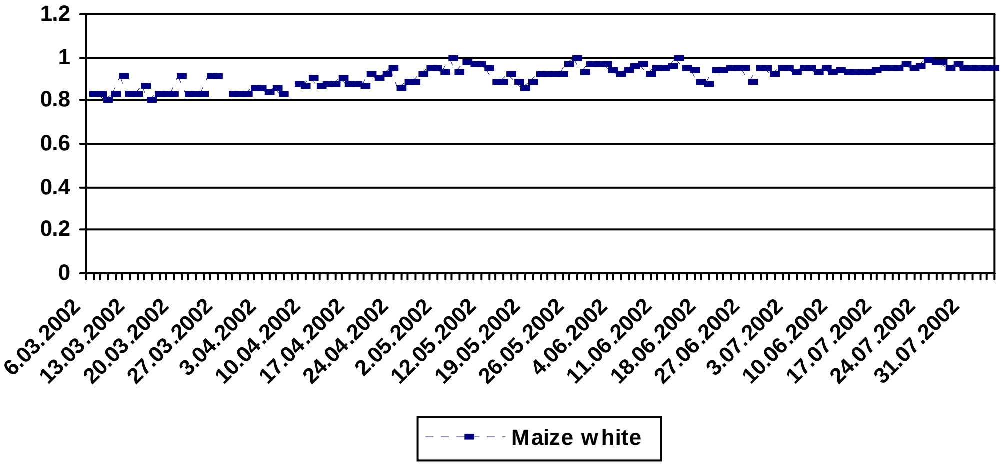


Figure 5.4: Ratio of wholesale to retail prices for white maize



5.1.3. Market integration test

The most important method of analyzing integration is co-integration. Co-integration means that (i) two variables, P_{wit} and P_{rit} (wholesale and retail prices, respectively), are each non-stationary in levels but stationary in first difference, $P_{wit}I$ (1) and $P_{rit}I$ (1). There exists a linear combination between these two series, which is stationary, P_{wit}--$P_{rit}I$ (0). Hence the first step of co-integration is determining whether the series are stationary or not.

In order to undertake stationary tests, we used the Augmented-Ducky-Fuller (ADF) method (Enders 1995; Gujarati 1998 This method tests the null hypothesis that P_t is non-stationary by calculating a t-statistic for $\beta = 0$ in:

$$\Delta P_t = \alpha + \beta P_{t-1} + \phi t + \sum_{k=2}^{n} \delta_k \Delta P_{t-k} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.1)$$

where P_t = P_t -P_{t-1}, and P_{t-k} = P_{t-k}- P_{t-k-1}; k = 2,3,4,…n; P_t is price at time t;,,, and are parameters to be estimated and $_t$ is the error term.

If the value of the ADF statistic is less than the critical values, it shows that P_t is stationary. If P_t is non-stationary, it should be determined whether P_t is stationary in the first difference by repeating the above procedure. To test for co-integration, Engle and Granger (1987) developed a two-step residual-based test. The first step is to conduct OLS regression of one price series (P_{wit} in this case) on another price series (P_{rit}) plus a constant and a time trend, which is known as co-integration regression.

$$P_{wit} = \theta + \lambda P_{rit} + \psi t + \nu_t \quad \text{...(5.2)}$$

where P_{wit} and P_{rit} are the wholesale and retail prices of crop i at time t; ,, and are parameters to be estimated and $_t$ is the error term.

The second step is to test whether the residuals ($_t$) from the co-integration regression in equation (2) are non-stationary by using the following test:

$$\Delta \nu_t = \eta \nu_{t-1} + \sum_{k=2}^{n} \omega_k \Delta \nu_{t-k} + \mu \quad \text{...(5.3)}$$

where $_t$ = $_t$-$_{t-1}$; $_{t-k}$ = $_{t-k}$-$_{t-k-1}$, $_t$, $_{t-1}$, $_{t-k-1}$ are, respectively, residuals at time t, t-1, t-k, and t-k-1; and are parameters to be estimated and is the error term.

According to equation (3), if the t-statistic value of is less than the relevant critical value, then the two price series are said to be co-integrated, and hence, the two markets are integrated. The results of the stationary tests are presented in Table 5.8.

The results of the stationary test indicate that both wholesale and retail prices pass the test, and we can further proceed to do integration test. For integration, we try to investigate or test between wholesale and retail prices for the different crops. The results of the integration tests are given in Table 5.9.

Table 5.8: Results of stationary test

Grain type	No intercept and trend	With intercept only	With intercept and trend
1. Teff			
(a) Wholesale price			
Adda teff	-6.12	-6.19	-6.25
Wollenkomi teff	-8.11	-8.08	-8.05
Bechena teff	-6.15	-6.25	-6.23
(b) Retail price			
Adda teff	-8.26	-8.22	-8.18
Wollenkomi teff	-8.34	-8.30	-8.27
Bechena teff	-5.09	-5.19	-5.17
2. Wheat			
(a) Wholesale price			
Wheat first	-3.22	-3.22	-3.36
Wheat second	-5.46	-5.60	-5.58
Wheat third	-3.10	-3.15	-3.10
(b) Retail price			
Wheat first	-3.31	-3.48	-3.52
Wheat second	-4.40	-4.57	-4.60
Wheat third	-4.04	-4.15	-2.52
3. Maize			
(a) Wholesale price			
White maize	-5.56	-5.79	-5.79
Maize mixed	-5.36	-5.60	-5.60
(b) Retail price			
White maize	-4.58	-4.73	-4.75
Maize mixed	-4.69	-4.82	-4.85
Critical values			
1%	-2.58	-3.49	-4.04
5%	-1.94	-2.89	-3.45
10%	-1.62	-2.58	-3.15

Note: The figures in the table refer to ADF test statistics with a four-period lag. The tested hypothesis is: H_0: Non-stationary and the alternative is H_1: Stationary.

Table 5.9: Results of integration tests

Crop type	Wholesale-retail market
1. *Teff*	
Adda teff	-6.04
Wollenkomi teff	-8.08
Bechena teff	-7.23
2. Wheat	
Wheat first	-5.43
Wheat second	-7.81
Wheat third	-6.54
3. Maize	
White maize	-5.98
Maize mixed	-6.96

The results of the integration test show that the wholesale and retail markets are integrated. In other words, there a exists long-run and stable price relationship between the two markets for the sample grain products. If there is interaction between a pair of markets, then there must be Granger causality—that is, one series may cause another and vice versa. Thus, the next step is to conduct such a test in order to determine the direction of causality. Theoretically, if a time series variable P_{wit} influences another series variable P_{rit}, then there exists a Granger causality relationship between these two variables in which P_{wit} Granger causes P_{rit} and vice versa. Formally, this test can be conducted based on the following model.

(i) $P_{wit} = \psi_{11}\Delta P_{wit-1} + \ldots + \psi_{1n}\Delta P_{wit-n} + \psi_{21}\Delta P_{rit-1} + \ldots + \psi_{2n}\Delta P_{wit-n} - \zeta_1 \left[P_{wit-1} - \alpha P_{rit-1} - \delta \right] + \varepsilon_{it}$ (5.4)

(ii) $P_{rit} = \psi_{31}\Delta P_{rit-1} + \ldots + \psi_{3n}\Delta P_{rit-n} + \psi_{41}\Delta P_{wit-1} + \ldots + \psi_{4n}\Delta P_{wit-n} - \zeta_2 \left[P_{wit-1} - \alpha P_{rit-1} - \delta \right] + \varepsilon_{2t}$ (5.5)

The hypotheses to be tested to determine the Granger causality relationship between wholesale and retail prices are:

(a)(P_{rit} does not Granger Cause P_{wit}); and
(b) (P_{wit} does not Granger Cause P_{rit})

Based on the integration test, an attempt was made to perform a causality test for the two markets, and the results are given in Table 5.10.

Table 5.10: Summary of Granger causality tests		
Crop type	P_{wit} does not Granger cause P_{rit}	P_{rit} does not Granger cause P_{wit}
1. *Teff*		
Adda teff	0.42	0.29
	(0.66)	(0.75)
Wollenkomi teff	0.35	0.33
	(0.71)	(0.72)
Bechena teff	0.84	14.40***
	(0.43)	(0.00)
2. Wheat		
Wheat first	11.64***	2.56*
	(0.00)	(0.08)
Wheat second	16.37***	5.24***
	(0.00)	(0.01)
Wheat third	29.77***	0.01
	(0.00)	(0.99)
3. Maize		
White maize	10.32***	0.97
	(0.00)	(0.98)
Mixed maize	11.75***	1.78
	(0.00)	(0.17)

Note: The unparenthesized figures are F-statistics, while the figures in parentheses are *p*-values.

*** Significant at 1% or less.

* Significant at 10%.

Table 5.10 reveals interesting information about the direction of causality between the two markets. The causality directions are from wholesale to retail for both white and mixed maize. Thus, the wholesale markets lead the retail markets for maize. With regard to wheat, there is a two-way interaction or causation between the two series.The influence of the wholesale market is stronger, however, than that of the retail market in all grades of wheat. This shows that wholesale markets do not receive adequate feedback from the retail markets, especially in the case of maize.

The results paint a different picture for *teff*, where there is a weak causality relationship (not statistically significant) virtually in all types. The only exception is *Bechena teff* in which the retail market leads the wholesale market. *Teff* markets do not appear to have strong causal relationships.

5.2. Determinants of grain prices

In the previous discussion, an attempt was made to indicate the nature of grain markets and the behavior of grain prices. Understanding the behavior of daily market grain prices requires a critical investigation of the determinants of these prices.

First, it is important to know how brokers set their selling price at the central market. The survey results show that about 69 percent of brokers used the price of the previous day in setting the current price for grain (Annex Table 2.12). Most brokers (78 percent) also take into account the prices of other brokers in setting their current sales prices (Annex Table 2.21).

Another important factor is related to supply and demand conditions. Brokers undertake personal evaluation of total arrivals before the market opens at 6 a.m. Reports of arrivals from clients and records of trucks at the entry gate are also used in assessing the magnitude of supply to the central market (Annex Table 2.15). On the demand side, brokers use, among other things, reports of regular buyers, personal observations of total buyers in the market, specific dates of the month (e.g., pay period), holiday seasons, and entry or presence of large buyers in the market (Annex Table 2.17). Most brokers do not incur financial costs in getting information about demand, supply, and price levels in the market. The only investment they need is a bit of their time and personal effort, although the quality of information they collect is likely to be low.

The ability of any market to function efficiently with respect to pricing depends in large part on the information available to market agents. Price determination requires information on daily demand, supply, quality of grain, previous stocks, and policy and related variables (such as time of government intervention). Government intervention in the grain market drives up grain prices. It has been documented that changes in daily price variability are crucially related to daily supply (which consists of new daily supply and the previous day's stocks), daily demand, extent of competition, and other factors.

In order to examine the competitive behavior of a market in a differentiated market structure, we used a hedonic model, which is a popular framework in grain marketing. The model specifies that price is a function of both supply and demand. The marginal implicit price of a characteristic is determined by differentiating the hedonic with respect to that characteristic, implying an empirical specification of the hedonic model of the form:

$$P_t = f(p_{t-1}, p_d, Dp, Dh) \qquad (5.6)$$

where P_t is the wholesale price of a given crop type on any given market day, $P_{t\text{-}1}$ is the closing price of the previous day, P_d is the average opening price (price registered at 6:00 a.m.), *Dp* is the dummy for the date of the month (1 if the date coincides with pay period and 0 otherwise), and *Dh* is the dummy for a holiday (1 if a major holiday is approaching and 0 otherwise). The dummies are interpreted as differences from the price of the pay period and holiday sales. The results of the regression analysis for wheat and maize crops are presented in Tables 5.11 and 5.12, respectively.[9]

As shown in Table 5.11, all the explanatory variables affect the wholesale price of wheat positively, and they are all significant except for holiday (Table 5.11). Unlike wheat, pay period and holiday are negatively correlated with the wholesale price of maize and are statistically insignificant. This is perhaps because maize is not the main food item for the majority of the urban population. The common feature of the two regressions is that the opening price appears to be the main determinant of the spot price of each crop.

Table 5.11: Results of the determinants of wheat price

Dependent variable logarithm of wholesale price of wheat	Coef.	Std. error	t	$P > \|t\|$	95% conf. interval	
Log of the average opening price	0.487	0.164	4.389	0.004	0.267	0.707
Log of the closing price of the previous day	0.510	0.174	4.537	0.004	0.288	0.733
Dummy for pay period	0.010	0.005	1.500	0.051	-0.003	0.024
Dummy for holiday	0.002	0.005	0.211	0.729	-0.014	0.018
Constant	0.010	0.081	0.127	0.905	-0.142	0.161

Heteroskedastic-consistent standard errors

Number of observations = 123

Observation-adjusted $R^2 = 0.97$

Prob > F = 0.000

9 A regression analysis for *teff* was not conducted, as it is highly heterogeneous compared with other crops.

Table 5.12: Regression results of the determinants of maize price

Dependent variable logarithm of wholesale price of maize	Coef.	Std. error	*t*	$P > \|t\|$	95% conf. interval	
Log of the average opening price	0.956	0.037	25.690	0.000	0.883	1.030
Log of the closing price of the previous day	0.056	0.037	1.496	0.137	-0.018	0.129
Dummy for pay period	-0.003	0.003	-0.924	0.357	-0.009	0.003
Dummy for holiday	-0.002	0.004	-0.426	0.671	-0.010	0.006
Constant	-0.050	0.018	-2.760	0.007	-0.086	-0.014
Heteroskedastic-consistent standard errors			Number of observations = 122 Observation-adjusted R^2 = 0.99 Prob > F = 0.000			

6. LARGE-SCALE OPERATORS

6.1. Wholesalers

The survey at the central market has shown that specialized wholesale operators are not a major part of the trading system. We made attempts, however, to contact grain wholesalers operating outside the central grain market. A total of five companies, namely Hawas Agri-Business Plc., Ambassel Trading House, Ethiopian Grain Trading Enterprise (EGTE, a parastatal formerly known as the Agricultural Marketing Corporation), Ethiopian Amalgamated Ltd., and Guna Trading House Share Company, were approached to provide information about their operations.

Storage facilities and capacities vary significantly between the different companies. The EGTE has the largest storage capacity and is the major provider of storage services in the country, whereas Ambassel has no storage of its own (Table 6.1).

Table 6.1: Storage capacity of the companies (quintals)

Capacity	Hawas	Ambassel	EGTE	Ethiopia Amalgamated	Guna
Own store	60,000	0	8.3 million	40,000	400,000
Rented store	n.a.	60,000	0	92,000	50,000

Note: n.a. means not available.

All the companies buy their stocks from surplus-producing areas without going to the central grain market in Addis. They buy directly from producers, traders, or agents in the different rural markets. Some of them also float tenders to buy grain. Two companies, EGTE and Ethiopia Amalgamated, were involved in importing wheat. Wheat and maize, the major crops handled, are sold to donors such as the World Food Programme (WFP), Euro Aid, and various nongovernmental organizations (NGOs). The Disaster Prevention and Preparedness Commission (DPPC) also gets some of its supplies from the companies. Other major customers are the Ministry of Defense and flourmills. The grain is cleaned, graded, and fumigated in some cases. Since *teff* is mainly bought by urban households and there are no large-scale processing or milling factories, the trading companies have minimal interest in the crop.

Grain trade is the major activity for EGTE, whereas the other companies undertake other activities as well, including merchandise trade, fertilizer trade, and export of pulses and oilseeds. The companies enter the grain trade in response to tenders or requests from the major buyers. These companies may carry out no purchase in some years or in most parts of a given year. For instance, only one company (Ambassel) bought maize in 2001/02. The quantity of grain handled is also smaller in some years. Even EGTE has sharply reduced its food grain purchases in recent years and diverted its resources to purchasing oilseeds and pulses for export. It has been reported that maize and sorghum are exported in years of bumper harvests. For instance, Guna exported about 200,000 quintals of sorghum and maize to Sudan in 2000/01.

Contract enforcement is a major problem of the trading companies. Three of the five companies had faced disputes in the preceding three years. One of the companies (EGTE) lost 104 million birr over the same period, while the other (Hawas) lost 1.7 million.

Grain prices at the central market start to increase whenever one or more of the companies are about to buy grain. On the other hand, prices decline if they are staying out of the market. The volatility of the market is partly induced by the occasional involvement of the companies. It appears that large-scale wholesalers operating on a more permanent and consistent basis would have a stabilizing effect on the market.

6.2. Large-scale processors

To understand the structure of grain-processing factories, a survey of factories was also implemented, and a total of eight public and private processors were interviewed through a structured questionnaire covering their operations through the end of 2002. The questionnaire asked the surveyed processors about a broad range of issues, including marketing, transport, storage facilities, and the role they envision for the government in regulation.

More than three-quarters of processors handle only one type of grain--wheat, for producing flour, spaghetti, and macaroni. It was also reported that the average actual processing capacity of these processors was 47 tons per day, while the potential was 65 tons per day. This result shows that the processors utilize only about 73 percent of their capacity, mainly owing to low demand for their products (consumers have a bias in favor of imported flour). The companies have reported that imported flour has depressed the price of local flour and their market share.

Most of the processors do not buy grain from the central grain market. Instead they purchase wheat from farmers' cooperatives, state farms, EGTE, and other wholesale suppliers. The majority of the flour factories procure locally produced wheat directly from the producing areas. Over 95 percent of the wheat requirement was met locally in 2001, and some 86 percent reported having contractual arrangements with local suppliers.[10]

Many of the processors have limited storage facilities, with an average storage capacity of 6,656 tons. More than 60 percent reported having less than the mean. Limited storage capacity implies that processors cannot take advantage of low prices prevailing immediately after harvest.

The major buyers or customers include distributors, defense, universities, bakeries, retailers, and individuals. Given the demand-constrained environment, credit sales are used to enhance sales. Nonetheless, as in the case of brokers and retailers, defaults are serious obstacles. Default was reported in almost half of the cases, and, on average, birr 272,000 had been lost in the preceding three years. Weak legal and contract enforcement mechanisms have constrained the operation of processing firms in Ethiopia.

7. CONCLUSION AND POLICY IMPLICATIONS

Despite some improvements following liberalization, grain marketing systems in Ethiopia are characterized by a lack of modernization, a limited number of large interregional traders with adequate storage and working capital, high handling costs, an inadequate market information system, weak bargaining power, and an underdeveloped processing industrial sector.

[10] Note that about a quarter reported to have purchased imported wheat in the domestic market that has come through food aid and emerging evidences indicate that this has a disincentive effect on local wheat producers though increasing the total supply of wheat and depressing prices in the local market.

Intermarket grain flow is coordinated by brokers in Addis Ababa, and the central market of Addis Ababa serves as the national clearinghouse of grains. This market has not experienced any improvement or expansion over the past five decades or so. It is a market where licensed traders and brokers operate along with too many informal intermediaries (without licenses and stalls). There is no police protection against unlicensed and illegal operators in the market. The central market is also a place of “refuge” for a number of unemployed people and criminals.

There is no independent grading and inspection agency that could assist both buyers and sellers. As a result, it is common for grain judged as the best by a regional trader to be downgraded by a broker or a buyer. In many cases, the grain is sold based on the grade determined by a buyer. Buyers have strong bargaining power in that they can postpone their purchase decisions and reduce the quantity purchased. For regional traders, an extended delay in sales leads to a lack of cash to continue buying grain from farmers, as well as additional costs of transport, handling, and storage. A shortage of capital has weakened the bargaining power of regional traders.

There is no single price in the market, and each transaction involves negotiation over the price and quality of grain. Informed buyers with good negotiation experience buy at lower prices, whereas uninformed and inexperienced ones buy at higher prices.

In cases where brokers fail to get a target price, they sell on credit to retailers and the retailers in turn sell on credit to final consumers. The importance of credit sales increases when there is glut in the market. Credit sales, however, present a huge risk. Many brokers, retailers, and regional traders had lost money over the preceding three years when clients who bought on credit failed to pay back. Creditors could not take defaulters to court because they had no written evidence, and the court system was too slow even if contracts had been documented. Trading relationships were essentially based on mutual trust, which has rapidly eroded in recent years. The most common ways of settling disputes were peer pressure and frequent visits and appeals to borrowers.

The empirical evidence reveals that there is no significant trading margin in the wholesale and retail markets of Addis Ababa. The presence of too many traders (licensed as well as unlicensed) has reduced trading margins. It has become impossible to benefit from scale economies in wholesaling and retailing.

Seasonality in supply and marketing are the main features of agricultural products in Ethiopia. Wholesale prices have been less variable during the postharvest period than during lean periods. Crop prices tend to decline during harvest because of an increase in supply and to increase during lean periods. It has been found that price stability is high when crop prices are low and vice versa. Seasonal indexes of wholesale prices are lowest during the months of March and April and highest during June and July. Seasonality indexes of all crop types have also shown an increasing trend over time, reaching their lowest point during peak periods and their highest point during lean periods.

One of the common features of the seasonal price indexes of the three crops is that the closing price index is lower than the opening price index. This suggests that the closing price is more stable than the opening price and that the opening price exhibits more variability with time. Apparently, sellers adjust their selling prices downward before the market closes. The intra-month price movements are much lower at the closing than the opening of the market. The seasonal effect is higher for wheat and maize than for *teff*. The relative stability of the seasonal indexes of *teff* might be due to the fact that it can be stored without fumigation for a long period of time. Of the three crops, the seasonality effect of maize is highest, a fact that is consistent with its high instability index.

The results of the integration test show that the wholesale and retail markets are integrated—that is, there is a long-run and stable price relationship between the two markets for the sample grain products. While the causality directions are from wholesale to retail for white maize, the causality runs in both directions for mixed maize. It seems that the direction of causality is stronger from wholesale to retail for mixed maize than the other way round (i.e., the retail price of mixed maize is highly influenced by the wholesale price). Thus, the wholesale markets lead the retail markets for maize. A similar picture has been observed for wheat: there is a two-way interaction or causation between the two series. Except for wheat third, for which the relationship is unidirectional (from wholesale to retail, but not vice versa), all wheat types have a Granger causality relationship in both directions. As in the case of white maize, the relationship is stronger from wholesale to retail than vice versa. This shows that Wholesale markets are somewhat efficient already and are more closely integrated with retail markets.A different picture emerges for *teff,* however, which shows a weak causality relationship virtually in all *teff* types. The only exception is *Bechena teff,* for which the retail market leads the wholesale market. In terms of grain types, the relationship of causality for wheat is stronger than both for maize and *teff*.

In general, the performance of the central market of Addis Ababa has been disappointing and is characterized by high risk, limited access to credit, low trade margins, and consequently low investment in marketing facilities and improved systems. As a result, consumers, traders, and producers have not benefited from the trading activities. The market needs improvement and modernization to ensure that it functions fairly and efficiently. A set of comprehensive and complementary measures should be taken to modernize the central grain market of Addis Ababa and consequently all other regional grain markets of the country.

First, brokers, regional traders, retailers, and large-scale wholesalers and processors appear to operate with no legal protection and virtually no recourse to courts. They operate in a trading environment where grades and standards are negotiated and informed buyers have stronger bargaining power than sellers. Brokers are involved in wholesaling and retailing with no regard to the conflict of interest that may arise in selling the grain of regional traders. There is no market information to guide the activities of traders and producers. The market is dominated by too many small and informal traders with very small financial resources and no social capital. Gangsters acting as intermediaries have made it extremely difficult and risky to trade at the central marketplace. Hence, the market has failed to grow and expand beyond cash-based spot markets or a physical cash market. There is a need to establish, strengthen, and develop important marketing institutions such as:

- a legal, regulatory, and enforcement authority to ensure stability of returns and justify investments in new technology;
- a formal system of grades and standards to reduce transaction costs and eliminate one major source of dispute between sellers and buyers;
- an agricultural marketing development council to find solutions to the various problems of the central market through participation of all stakeholders;
- an association of regional traders, brokers, and other participants to lobby for more public investment and legal protection;
- an agricultural marketing research institute to collect and analyze market information; and
- market information to reduce risk in producing and handling grain.

A well-functioning legal and political framework for market activity is critical given the conditions of market failure and the imperfect information system. Strengthening the regulatory capacities of the state and establishing the various market institutions would ensure modernization and specialization in wholesaling, retailing, and brokerage activities.

Second, the system of price discovery favors the buyer, especially at times of surplus production. There is downward pressure on prices at all levels of the market chain, and the ultimate loser is the producer (the small farmer). This has been the case partly because traders do not have the financial resources and storage facilities to buy when prices are low and sell when prices are higher. Moreover, market prices have never favored small rural producers, who have no political power. According to the pluralist view of policy formulation, governments do not pursue transcendent (inspiring) social interests; rather they respond to private demands. Public policy is regarded as an outcome of political competition among organized groups. Organized urban consumers press for low-priced food, while rural producers demand higher prices. Since the cost of organization for farmers is high, pricing policies adopted in Africa are not favorable to farmers (Bates 1990). The bargaining power of farmers in Ethiopia needs to be strengthened through the formation of farmers' unions at all levels (from district to national level), and various associations representing different group of producers must be encouraged. Marketing cooperatives should also be encouraged as part of the effort to empower small producers.

Third, there is a need to improve the marketing system at the central grain market. Introducing trading based on organized exchange or auction would greatly improve the efficiency of the market. A futures contracts market, which specifies the minimum grade that must be delivered in fulfillment of the contract at some future date, would transform the marketing system. The existing spot or cash market has imposed significant transaction costs and created enormous uncertainty.

Fourth, the marketing facility at the central market is overcrowded and extremely unsuitable for regional traders. The regional traders have access to the marketplace only three days each week and for only three hours on each day. It would be appropriate to create a separate center and adequate space for regional traders so that they can operate for the whole day and at least

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five or six days of the week. In fact, lack of space has been identified as one of the chief problems at the central market of Ababa. Thus, decentralizing the central market by establishing market centers at different corners of Addis Ababa is also important. For example, wheat, *teff,* and maize marketing centers could be established along the Ring Road or along the main roads leading to the surplus-producing regions. This decentralization of the grain market would greatly improve the efficiency of the marketing system and benefit the economy at large.

Fifth, there is a need to develop transport and communication systems. Severe infrastructural deficiencies have increased transaction costs for regional traders. Telephone connections are either absent or unreliable. Poor roads and trucking systems have increased the cost of grain transport. Improving the quality of roads and communications would increase efficiency of the grain market and increase production by reducing transaction costs and allowing for timely delivery of inputs. Moreover, improved access to timely market information could help traders respond to policy-induced measures or other shocks. It would also help policymakers to monitor the evolving effects of grain market liberalization and identify problems that require intervention in a timelier manner. Banking and credit facilities need substantial improvement to make effective use of any improvement in physical infrastructure.

Sixth, the absence of strong wholesale activity has severely hampered the efficient operation of the market. In particular, regional traders incur huge costs and uncertainty when searching for buyers. The presence of regular wholesalers with sufficient capital and storage in the market chain could mean that regional traders act as direct suppliers of the wholesalers with no cost for the services of intermediaries. Building the capacity of existing processors and encouraging the establishment of new ones would also create a similar opportunity for regional traders.

Food aid has saved the lives of millions of people, but it has also negatively affected prices and investments by traders and processors. Food-aid grains sold in the market are considered distortionary because they create uncertainty over quantity released to the market and time of arrival. This uncertainty makes it very difficult for traders, processors, and some surplus-producing farmers to adjust and plan their investment. Cheap flour imports have also adversely affected the market. Thus there is a need for more proper targeting of food aid and protection of the domestic grain market from cheap imports.

Finally, one of the main factors responsible for the poor performance of the grain market is low demand. Widespread poverty has depressed demand and constrained grain trade in the country. Government intervention to improve income and employment opportunities would boost demand and prices. The implication is that focusing on supply side interventions alone would not bring self-sustaining development in the country. Demand for agricultural products must expand rapidly to absorb expansion in supply. Demand side interventions should be directed at facilitating transformation of the entire economic structure or ensuring rapid expansion of the non-agricultural sectors. The whole exercises of agricultural development led industrialization will be self-defeating unless it is accompanied by increasing employment and rising productivity of the non-agricultural sectors to resolve demand constraints to agricultural growth and development.

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ANNEX TABLES

Annex 1.1: Notes on price discovery

By G.R Tomek and L.K Robinson, 1981, London: Agricultural Market Product Prices, Cornell University.

The process by which buyers and sellers arrive at specific prices and other terms of trade is known as price discovery. The following are some of the major categories of price discovery:

i. Informal negotiation between individuals – a range of prices rather than a single equilibrium is likely to prevail. This range may reflect imperfections in the pricing method, including the relative bargaining power and trading skills of the participants. Price reporting where so much variability exists is time-consuming, expensive, and sometimes inaccurate. This system of pricing becomes progressively less satisfactory as the volume of production per farm increases and the opportunity cost of time spent in bargaining rises. For this reason, as agriculture becomes more commercialized, the price a farmer receives is less likely to be determined by individual negotiations.

ii. Trading on organized exchange or auction, including both specific market places and electronic exchange or auctions – Two types of trading occur on organized markets. One is the 'spot' or cash market which involves trading in actual commodities, normally on the basis of samples. The other is in futures contracts which specify the minimum grade or particular grade of a commodity which must be delivered in fulfillment of the contract at some future date.

   The structure of such markets can be viewed as a continuum from pure competition to absolute monopoly. A simple division is possible, however, between 'competitive and non-competitive'.

iii. Pricing via formulas – pricing formulas are usually based on some reported price, such as a quotation derived from a central market or the price paid to producers in a particular region or location. A well-designed formula offers the advantage of providing an impersonal, prompt, and low-cost method of adjusting prices. Once adopted, a pricing formula makes it possible to change prices more or less automatically in response to changes in the designated base price or whatever movers are incorporated in the formula.

iv. Bargaining conducted by producer associations or co-operatives – Dissatisfaction with price levels and other terms of trade has led farmers, in some cases, for form bargaining associations or coperatives in an attempt to negotiate with buyers. The fundamental weakness of voluntary association to raise prices on a national scale is that it is difficult to get everyone to join especially when the potential benefits of remaining outside of the associations are so great.

v. Administrative decisions, both in the private and public sectors – the objective of government administered pricing in agriculture in some cases is simply to provide a floor under prices in years of large crops so as to limit price fluctuations, while in others it is to provide incentives to increase production, as during World War II. The resource allocation function of prices is often sacrificed in order to achieve some welfare objective. There is no reason why society should not elect to do so, but if prices are to be used as an instrument to raise or maintain incomes, other methods must be employed to guide production or maintain consumption.

Annex Table 2.1: Status of the respondent in the business

Status	Number	%
Owner	11	16.4
Owner-manager	34	50.7
Manager	7	10.4
Family	10	14.9
Employee	5	7.5
Total	67	100.0

Annex Table 2.2: Legal status of the business

Status	Number	%
Sole proprietorship	53	79.1
Private share company	14	20.9
Total	67	100.0

Annex Table 2.3: How do nonlicensed brokers assist licensed brokers?

Assistance	Yes	No
Bring buyers	38 (95.0%)	2(5.0%)
Bring new suppliers	15 (37.5%)	25(62.5%)
Gather price information	19 (47.5%)	21 (52.5%)
Gather information on supply	13 (32.5%)	27 (67.5%)
Gather information on buyers	16 (40.0%)	24 (60.0%)

Annex Table 2.4: Mode of payment for nonlicensed brokers

Mode of payment	Yes	No
On commission basis	26 (65.0%)	14 (65.0%)
Fixed rate per day	2 (5.0%)	38 (95.0)
No payment (they are paid by other party)	16 (40.0%)	24 (60.0%)

Annex Table 2.5: How do nonlicensed brokers obstruct operation?

Obstruction	Number	%
They split the market	16	40.0
They set high prices for grains	17	42.5
They force others to switch clients	5	12.5
They provide lower-quality grains at lower prices	2	5.0

Annex Table 2.6: Risk of failure while sending money through transporters

Response	Number	%
Yes	15	46.9
No	17	53.1
Total	32	100.0

Annex Table 2.7: Reasons for using transporters for transferring money

Reason	Yes	No
No banks	23 (71.9%)	9 (28.1%)
No transaction cost	8 (25.0%)	24 (75.0%)
Regional traders' preference	7 (100.0%)	0

Annex Table 2.8: Have you ever experienced betrayal by transporters?

Response	Number	%
Yes	4	6.0
No	63	94.0
Total	67	100.0

Annex Table 2.9: Is your storage capacity adequate for your business?

Response	Number	%
Yes	20	29.9
No	47	70.1
Total	67	100.0

Annex Table 2.10: Have you faced difficulty finding storage for unsold grain?

Response	Number	%
Yes	21	31.3
No	46	68.7
Total	67	100.0

Annex Table 2.12: Do you consider yesterday's price in setting current price?

Response	Number	%
Yes	46	68.7
No	21	31.3
Total	67	100.0

Annex Table 2.13: Methods of knowing the previous day's price

Method	Yes	No
Consider the price of the dominant broker	5 (10.9%)	41 (89.1%)
Consider the price at which most brokers sold	24 (52.2%)	22 (47.8%)
Own price of yesterday	31 (68.9%)	14 (31.1%)

Annex Table 2.14: Do you consider supply situations in setting current price?

Response	Number	%
Yes	55	82.1
No	12	18.9
Total	67	100.0

Annex Table 2.15: Methods of knowing the supply situation

Method	Yes	No
Report of arrival from clients	25 (45.5%)	30 (54.5%)
Personal evaluation of total arrivals before the market opens	44 (80.0%)	11 (20.0%)
Records of trucks at the entry gate	17 (31.5%)	37 (68.5%)
Exchange of information with other brokers	33 (60.0%)	22 (40.0%)

Annex Table 2.16: Do you consider overall production in setting prices?

Response	Number	%
Yes	26	38.8
No	41	61.2
Total	67	100.00

Annex Table 2.17: Do you consider demand in setting prices?

Response	Number	%
Yes	58	86.6
No	9	13.4
Total	67	100.00

Annex Table 2.18: Methods of knowing number of buyers in the market

Method	Yes	No
Report of arrival from clients or regular buyers	29 (50.0%)	29 (50.0%)
Personal observation of total buyers in the market	46 (79.3%)	12 (20.7%)
Specific dates of the month	25 (43.1%)	33 (56.9%)
Holiday seasons versus nonholiday seasons	38 (65.5%)	20 (34.5%)
Entry or presence of large buyers in the market	48 (82.8%)	10 (17.2%)
Exchange of information with other brokers	33 (60.0%)	22 (40.0%)

Annex Table 2.19: Brokers' opinion about the overall demand for grain in 2000 compared with the previous year

Opinion	Yes	%
Increased	7	10.4
Decreased	52	77.6
No change	7	10.4
No idea	1	1.5
Total	67	100.0

Annex Table 2.20: Reasons for declining demand for grain in 2000

Reason	Yes	%
Increase in grain supply	13	25.0
Low purchasing power of consumers	26	50.0
Fewer buyers	2	3.8
Others		13.5
No idea	4	7.7

Annex Table 2.21: Do you consider prices of other brokers in setting prices?

Response	Number	%
Yes	52	77.6
No	15	22.4
Total	67	100.00

Annex Table 2.22: Types of brokers whose prices are considered in setting daily prices

Type of broker	Yes	No
Dominant broker	22 (42.3%)	30 (57.7%)
Friendly broker	42 (80.8%)	10 (19.2%)
Brokers in nearby stall	49 (94.2%)	3 (5.8%)

Annex Table 2.23: Price adjustment between the opening and the closing of the market

	Frequency				
Time	0	1	2	3	5
6:00–7:00 a.m.	3 (8.8%)	7 (20.6%)	10 (29.4%)	10 (29.4%)	4 (11.8%)
7:01–8:00 a.m.	2 (5.4%)	17 (45.9%)	13 (35.1%)	5 (13.5%)	
8:01–9:00 a.m.	5 (19.2%)	14 (53.8%)	4 (15.4%)	3 (11.5%)	

Annex Table 2.24: Are you willing to pay for an agency that provides grading and certification?

Response	Number	%
Yes	17	25.4
No	50	74.6
Total	67	100.00

Annex Table 2.25: Services received from licensing authorities

Response	Number	%
Nothing	64	95.5
Collect taxes	2	3.0
No idea	1	1.5

Annex Table 2.26: Brokers' opinion about the level of taxation

Opinion	Number	%
High	40	95.2
Average	2	4.8
Total	42	100.00

Annex Table 2.27: Brokers' opinion about the method of taxation

Opinion	Number	%
Inconsistent with other income	37	88.0
Needs improvement	2	4.8
Fair	2	4.8
It does not include unlicensed operators	1	2.4
Total	42	100.00

Annex Table 3.1: Status of the respondent in the business

Status	Number	%
Owner	25	23.4
Owner-manager	50	46.7
Manager	5	4.7
Family	19	17.8
Employee	8	7.5
Total	107	100.0

Annex Table 3.2: Legal status of the business

Status	Number	%
Sole proprietorship	102	95.3
Private share company	4	3.7
Public enterprise	1	0.9
Total	32	100.0

Annex Table 3.3: Cost structure of grain trade (in birr)

Cost item	Amount (in birr)	% of total cost
Cost of loading/unloading per quintal	2.0	0.04
Store charges per month	400.1	7.9
Transport cost per quintal	47.2	0.9
Taxes and other charges per year	1,854.4	36.8
License renewal fee per year	92.2	1.8
Payment for guards per month	27.8	0.6
Utility expenses	381.3	7.6
Cost of parking per day	51.3	1.0
Maintenance cost per year	960.7	19.0
Insurance	509.4	10.1
Other costs	520.0	3.9

Annex Table 3.4: Do you own the premise in which you conduct your business?

Response	Number	%
Yes	26	24.3
No	81	75.7
Total	107	100.0

Annex Table 3.5: Storage charge and ownership structure

Ownership type	Store charge per month (in birr)
Government	462.1
Private individuals	567.4

Annex Table 3.6: How do you describe the quality of your store?

Response	Number	%
Shaded only	28	26.2
Proper stall with a locker	79	73.8
Total	107	100.0

Annex Table 3.7: Average number of assets owned

Type of asset	Number	Minimum	Maximum
Small trucks	0.22	0.0	1.0
Big trucks	0.0	0.0	0.0
Personal automobiles	0.55	0.0	3.0

Annex Table 3.8: Are you member of *iqub*?

Response	Number	%
Yes	37	34.6
No	70	65.4
Total	107	100.00

Annex Table 3.9: Do you have license from Trade Industry Bureau?

Response	Number	%
Yes	73	68.2
No	34	31.8
Total	107	100.00

Annex Table 3.10: Retailers' opinion about services received from licensing authorities

Opinion	Number	%
Provide no services	99	99.0
Facilitate access to bank credit	1	1.0

Annex Table 3.11: Are you a member of a trade association?

Response	Number	%
Yes	77	28.0
No	49	72.0
Total	107	100.00

Annex Table 4.1: Status of the respondent in the business

Status	Number	%
Owner	5	15.6
Owner-manager	24	75.0
Manager	1	3.1
Family	2	6.3
Total	32	100.0

Annex Table 4.2: Complementary activities performed by regional traders

Activity type	Yes	No	Total
Merchandise trade	4	28	32
Hotel services	0	32	32
Flour (grain) mill	2	0	2
Corrugated iron trade	1	0	1

Annex Table 4.3: Average number of assets owned

Type of asset	Number	Minimum	Maximum
Small trucks	0.33	0.0	2.0
Big trucks	0.0	0.0	0.0
Personal automobiles	0.18	0.0	1.0
Store owned (in square meters)	1769.0	0.0	400.0
Store rented (in square meters)	834.0	12.0	500.0

Annex Table 4.4: Legal status of the business

Status	Number	%
Sole proprietorship	2	6.3
Private share company	30	93.7
Total	32	100.0

Annex Table 4.5: Cost structure of grain trade (in birr)

Cost item	Amount (in birr)	% of total
Cost of loading/unloading per quintal	31.4	0.13
Store charges per month	159.6	0.66
Transport cost per month	20,815.9	85.5
Commission for brokers	486.9	2.0
Charges at *ehil berenda(*central market**)**	23.6	0.10
Taxes and other charges per year	2001.2	8.22
License renewal fee per year	86.5	0.36
Payment for guards per month	44.7	0.18
Gross return from grain trade	8,547.3	35.13
Utility expenses	110.0	0.45
Cost of parking per day	51.3	0.21
Other costs	520.0	2.14
Total cost	24,331.1	100.00

Annex Table 4.6: Means of getting price information at Addis Ababa

Method	Number	%
Through telephone only	16	53.3
Via telephone and letter	2	6.7
Through other traders and brokers	10	33.4
Personal visit at Addis Ababa	1	3.3

Annex Table 4.7: Traders' opinion about the level of taxation

Opinion	Number	%
High	26	86.7
Average	4	13.3

Annex Table 4.8: Have you ever experienced shortage of cash because of credit sales?

Response	Number	%
Yes	20	62.5
No	12	37.5

Annex Table 4.9: Effect of credit sales on the business

Effect	Number	%
Reduce quantity purchased	15	50.0
Lead to bankruptcy	5	16.7
Have no effect	3	10.0
Have no significant impact	7	23.3

CHAPTER SEVEN

Post-Harvest Grain Management and Food Security in Ethiopia

Abebe H. Gabriel and Bekele Hundie

Post-Harvest Grain Management and Food Security in Ethiopia

1. Background and Justification for the Study

1.1. The Significance of Foodgrains in Consumption and Production

Foodgrains (cereals, pulses, and oil crops) constitute the major source of food in Ethiopia; they account for 82 percent of total calorie intake[18] and 70 percent of food expenditure (CSA 1988; Abebe 2000:260). Cereals alone provide about 70 percent of the average Ethiopian's calorie intake (Howard et al. 1995). Studies conducted in some parts of the country (Shiferaw 1986; Tesfaye 1989) have reported even higher figures[19] indicating that foodgrains account for more than 95 percent of total food requirements.

This heavy dependence on foodgrains is well reflected in the cropping patterns. The country's agricultural production is dominated by grain. Out of 16.5 million hectares of land under cultivation, 14.6 million (88.5 percent) are under annual crops (Tesfaye et al. 2001).

Grain production in Ethiopia is virtually a smallholder farmer's activity, and yield levels are among the lowest in the world. Studies indicate that only about a quarter of the total foodgrains produced by farmers is marketed (Gabre-Madhin 2001; Abebe 2000; Gebre-Meskel, Jayne, and Shaffer 1998); the bulk of production is retained for on-farm consumption[20].

Table 5. Average Area, Output, and Yield Levels of Cereals (1974-99)

Crop	Area (000 ha)	Output (000 qts)	Yield (Quintals/ha)		
			Ethiopia	World Best	World Average
Wheat	665.57	7,787.27	11.71	57 (Holland)	28
Barley	838.97	9,164.25	11.06		
Teff	1,535.83	13,097.21	8.55		
Maize	1,033.11	16,063.96	15.48	74 (New Zealand)	30
Sorghum	837.86	10,134.58	11.92	48 (Spain)	13
Cereals (Total)	**5,115.00**	**57,869.41**	**11.28**		

Source: Ethiopian Economic Association 2002. (for Ethiopia)

Concern over marketed foodgrain surplus has always been at the center of policy formulation and implementation. In the past, the government tried different methods to control the marketing of foodgrains. For example, the state-owned Agricultural Marketing Corporation (AMC), which was established in 1976, fixed grain prices at below market levels and set a compulsory procurement quota. Another effort involved the use of state farms to capture production ,since they found it difficult to control marketed surplus of food through markets

[18] The most important grains in terms of consumption are teff, wheat, and maize, which together constitute roughly two-thirds of caloric intake in Ethiopia (Alemayehu 1993).

[19] A high concentration of cereals (over 75 percent) in food intake is a symptom of an unbalanced diet. Diets high in cereals and tubers are low in micronutrients. (FAO 1998)

[20] Of the total grain production, some 72 percent is retained for on-farm uses (Gebre-Meskel, Jayne, and Shaffer 1998).

only (see Abebe 2000: 80–83). That practice lasted for more than a decade, between the late 1970s and early 1990s. However, although state farms allowed the government to directly access and control grain output, their contribution was insignificant, accounting for only 2.8 percent of total cultivated area and 3.6 percent of grain production (Abebe 1990; PMGSE 1984. The AMC had an extensive network of about 2,200 warehouses throughout the country with a total capacity of more than 1 million tons of grains (Alemayehu 1993). With the change in government in the early 1990s, the AMC's importance dwindled.When it was downsized into the Ethiopian Grain Trade Enterprise, its primary role was to manage buffer stocks, acting as a market stabilizer. With pro-market reforms in place, the single most important source of marketed surplus of foodgrains is expected to be the smallholder farmers who also retain a significant proportion of their output for household consumption.

1.2. Post-Harvest Grain Management as a Missing Link

The crucial importance of ensuring sustained levels of marketed food surplus, both in terms of quantity and fair price, cannot be overemphasized if food security is to be attained in Ethiopia. However, government policies have focused more on aspects of production and marketing and less on what happens inbetween these two processes. For example, supporting increased grain production through improved agricultural technologies has been heavily emphasized. Indeed, efforts to improve grain production technologies have, for some foodgrain crops such as maize, yielded such remarkable results that prices declined dramatically. This, in turn, has generated arguments as to whether market stabilization mechanisms should be introduced to absorb price shocks, thus preventing depressed market prices from acting as production disincentives.

It is often assumed that the bulk of grain output is marketed soon after harvest, which fails to appreciate the fact that most farmers produce foodgrains mainly to provide their households with food, and they only consider selling grain if there are surpluses. Foodgrains are retained for longer periods, with sales staggered over several seasons. Nevertheless, most of the sales are concentrated in the few months immediately following harvest. Estimates show that about 79 percent of farm households' annual grain sales occur in the period between January and March[21] (Gebre=Meskel, Jayne, and Shaffer 1998). Farming systems that integrate crop and livestock husbandry tend to have a higher capacity to earn cash by rearing and selling of small ruminants (sheep and goats). Taking into consideration the 75 percent retention rate by farmers and the 79 percent concentration rate of sales between January and March, the proportion of grains that are marketed immediately after harvest season amounts to about 20 percent of total production, which also implies that as much as 80 percent of total production is either retained for household consumption or marketed in a seasonally staggered fashion.

In Ethiopia, farm-level storage of grain includes grain pits, underground holes, and sacks. Traders store in small warehouses of varying capacities with poor ventilation and dirt floors (Dadi, Negassa, and Franzel 1992. Moreover, treatment to prevent damage (such as aeration or application of pesticides) is seldom practiced at the farm level, as is advisable, and treatment once damage becomes evident is mostly limited to aeration. This is because the designs of the storage facilities do not allow easy ventilation, or because farmers cannot afford pesticides, or even because treatment facilities are simply not available. Since storage

[21] This implies that farmers bear the full price risk in marketing their output, without informal mechanisms to lock in prices and without the financial means to withhold sales to mitigate the fall in prices at harvest (no forward contracts or credits) (see Gabre-Madhin 2001)

conditions are poor both on the farm and in warehouses, damage to grain from pests and moisture is high. Estimates suggest that the magnitude of post-harvest loss in Ethiopia is tremendous. Depending on the post-harvest handling method, losses range from 5 to 19 percent for maize, 6 to 26 percent for millet, 6 to 23 percent for wheat, and 5 to 20 percent for teff (Dereje 2000). Although storage capacity at the macro level has increased since the enactment of market reforms in 1991, roughly two-thirds of traders indicate that their storage facilities are still inadequate in terms of availability, capacity, and location, with 19 percent of traders reporting in 1998 that they were unable to obtain rented storage space (Gebre-Meskel, Jayne, and Shaffer 1998). Inadequate storage, combined with damage risks, make traders unwilling to store stocks beyond the minimum turnover period.

In Ethiopia, little or no processing is done along the marketing chain. Marketing functions are limited to transportation and minimal storage. Hence, in view of the imminent vulnerability of foodgrains to damage, the risk of loss is high.

Absence of mechanisms for general post-harvest management, including handling and treatment, is probably one of the factors that induce farm households to dispose of most of their grains immediately after harvest, with plans to buy as needed. Unfortunately, cash can be quickly spent in many ways. This, among other things, affects intrahousehold distribution. Grain consumption is distributed among members of households more fairly than cash obtained from grain sales. In many rural areas, marketing (particularly for the purpose of household consumption) is primarily the domain of female household members (housewives). The women sell small amounts of grain, chicken, eggs, butter, and so forth and use the proceeds to purchase household consumption items (such as oil, detergents, salt, and spices). Usually such activities take place throughout the year, in some places as frequently as once or twice a week. When relatively larger sums of money are needed, households resort to selling small ruminants, heifers, or larger volumes of grain. Such transactions are left to the heads of households, who are predominantly men.

Because of a lack of saving institutions in rural Ethiopia, holding stocks of grain at the farm-level may be considered a close substitute for cash banking. And, the convenience of having a stock of grain to draw on all year round may be an important inducement for farmers to hold stocks of grain. It is also expected that farmers' stock management may include the practice of lending or selling grains, at different seasons of the year, to other farmers for later repayment either in kind or cash. Hence, in the absence of well-functioning formal financial institutions, grain stock management may be an important method of assuring household food security.

Therefore, if food loss is to be minimized, the case is strong for a sound post-harvest grain management system. This is especially so for Ethiopia where most of thepeople are food insecure. It must be recognized that post-harvest grain management practices and capacities (and not just production and marketing) are important for many reasons, including the achievement of food security. Clearly, a better post-harvest grain management system would minimize the size of the loss. This is in addition to the potential employment and income linkage effects and gains from the grain management activities.[OK?] Nevertheless, very little effort has been made to study post-harvest management practices and capacities in Ethiopia. Those studies that remotely touch on post-harvest aspects only focus on marketing. Understandably, their policy recommendations do not go beyond the improvement of transportation, storage, and information infrastructure, and regulatory frameworks (see, for example, Alemayehu 1993; Wolday 1994, 1999; Bekele and Mulat 1995), with little mention of processing as an important post-harvest grain management activity. A few studies (for example, Jonsson 1972; Dereje 2000) focus on engineering and design aspects of storage infrastructure without any reference to wider perspectives such as food security.

2. Problem Statement

It is ironical that the immediate victims of food insecurity have traditionally been farmers, that is, the very producers of food. Each year, despite weather conditions, hundreds of thousands of rural households suffer food insecurity. They literally depend on food aid for their survival.

The fact that farm households have direct claims on their own production means that they depend less on markets in meeting their food consumption requirements. However, harvest is mostly once a year, or at most twice, with about 95 percent of production coming in at once. Long gestation periods coupled with low productivity levels have the effect of constraining both the flow and quantity of grain available from own production. Consequently, many rural households run the risk of food insecurity for several seasons of a year. Seasonality of food security corresponds closely with food production cycles. Farm households are relatively more food secure in the season immediately after harvest and insecure for longer periods, extending up to the next harvest season. The extent of food insecurity is most severe during land preparation and sowing periods, whereas the seasons following harvest are when the largest volume of grain is available at the household level and also at market levels—since these are the major marketing seasons as far as peasant households are concerned. One of the factors that contribute to a farmer’s decision to dispose of foodgrains at once may be the need for cash to payvarious dues (to government such as taxes, fees, loans) and to meet social obligations (loans, festivities).Fear of the risk of post-harvest grain loss is another factor.

Both seasonality in grain availability (at household and market levels) and household food security are probably related to farmers’ post-harvest grain management systems and capacities. Smoothing food consumption from one season to the next, thus ensuring stability in food availability in markets and food prices, probably depends on an efficient post-harvest grain management system not only at the household level, but also at the macro (national) level. Unfortunately, this crucial area has not received the attention it deserves. This is probably because of the often easily held assumption that what matters is production, and that success in increasing production and productivity will lead to increased availability of grains both at the household and market levels (see also Goletti and Wolff 1999). It is interesting to note that ”the strategy of decreasing post-harvest losses is more economical because it requires smaller inputs per unit of the final product than a strategy of increasing production extensively, especially in the short –run” (Toma, Fansler, and Knipe.1990).

The country’s grain production and price trends clearly demonstrate the failure of post-harvest grain management systems to respond sufficiently to increases in production, so as to stabilize grain markets. Often, boom cropping years are followed by depressed prices. Recent evidence shows that cereal production increased by 19 percent between the 1999/2000 and 2000/2001 crop year. Prices, on the other hand, declined by up to 40 percent (MoA 2001). There were field reports that farmers found it difficult to sell their products since the prices offered were extremely low. This may be partly due to the fact that agricultural commodities are rarely processed before sale to the consumer; they are often marketed as harvested without undergoing any transformation process. This makes storage very difficult for the farmers since most of the commodities are perishable, and farmers generally lack the infrastructure necessary to preserve the commodities from damage. Therefore, it has been witnessed that, at the macro level, the poor post-harvest grain management capacities could not live up to the production expectations, leading to depressed market prices with pernicious disincentive effects on producers. Similarly, at a micro level, the farm households, realizing the poor capacity of their post-harvest grain management systems, tend to dispose of most of their grain immediately after harvest when prices are the lowest of any season in the year. The problems caused by poor post-harvest grain management are similar at both the macro and micro levels: physical crop damage, quality deterioration, and value depreciation. Obviously, the implications for food security at national as well as household levels are of paramount significance for a country such as Ethiopia, where food insecurity has become a structural problem. It is important to examine the post-harvest grain management practices and capacities of farmers and their effects on food security.

3. Purpose and Objectives

The purpose of this study is to explore the relationship between farmers' post-harvest grain management practices and capacities and the availability of adequate household food supplies.

Specific objectives of the study are to

i) Identify and document the different post-harvest grain management processes and techniques practiced by farmers and investigate the factors that determine the choice of a given (or a set of) post-harvest grain management technique over other techniques;

ii) Examine the extent to which farmers' perception of risk of post-harvest grain loss influences their marketing behavior. In particular, the study seeks to explain why farmers dispose of most of their output immediately after harvest when prices are low;

iii) Investigate the relative importance of the potential risk associated with physical post-harvest grain losses and price risk in explaining farmers' post-harvest grain management practices and their impact on food security;

iv) Explore the extent to which intercrop differentials in post-harvest risk of loss are important factors in determining the share of marketed surplus of foodgrains.

v) Highlight crucial policy issues that relate to attainment of food security objectives through improvement in the capacities and practices of post-harvest grain management, at both the macro and micro levels of organization.

4. A Conceptual Framework

Post-harvest grain loss is the decline of quality, quantity, or both in grains during the time between harvest and consumption. Reduction of food loss is sometimes considered a "third dimension" to the world food supply equation, along with increases in food production and population (Toma, Fansler, and Knipe 1990). That is, an adequate world food supply depends on food production minus crop losses keeping pace with population growth. Crop losses occur at all stages of post-harvest handling, including pre-processing, transportation, storage, processing, packaging, and marketing. Post-harvest grain losses can be classified as quantifiable (decreases in weight and economic value) and nonquantifiable (decreases in nutritional value, energy, and quality) (Toma, Fansler, and Knipe 1990). In a wider sense, the magnitude of post-harvest loss goes beyond the physical deterioration in quality to include "sunk" cost in terms of the wasted inputs used to produce the lost grain.

As noted earlier, the common forms of post-harvest grain management activities include storage, treatment, processing, and stock management (for example, loans, sales, purchases). In the absence of well-functioning rural savings or credit institutions , holding stocks of grain at the farm level may be considered a close substitute for cash banking. In addition, the convenience of having grain stock to draw upon throughout the year may also play an important role in the farmer's decision to hold stocks of grain. Farmers may also practice a kind of stock management when they lend or sell grains, at different seasons of the year, to other farmers for later repayment—either in kind or cash. Hence, where formal financial institutions do not exist, grain stock management may be an important method of ensuring household food security.

The extent of the post-harvest loss and the management choices differ with crop types. For perishable vegetables, post-harvest losses can go as high as 100 percent (Toma, Fansler and Knipe 1990). Cereals and pulses are also vulnerable to insect attack at all stages and therefore require continuous protection. Inadequate storage immediately after harvest and before processing adds to the problem. Damage from infestation continues during transportation and the storage period before processing, causing an estimated overall loss of more than 30 percent.[22] Experts in this kind of analysis cite minimum post-harvest losses of 10 percent for durable crops.

The relationship between post-harvest grain management practices and food security is conceptualized in Figure 1. At the household level, food security can be defined as availability of and sustained access to adequate food. It is determined by the amount of output produced (1, in Figure 1), which is itself a function of an adequate endowment of resources, the amount of post-harvest grain loss (3), and food prices (2).

Grain loss, either in terms of quantity damaged or quality deteriorated, is related to post-harvest grain management practices (5), including storage, handling, processing, and stock management, which in turn are a function of endowment and access to resources including credit (6). The output level may also influence the choice of grain management practices (7), which determines the magnitude of post-harvest grain losses (8) as well as farmer's stock management behavior.

The magnitude of post-harvest grain losses, whether actual or expected, influences farmers' behavior in the marketplace (8); that is, in the absence of working insurance markets, the fear of facing a high risk of grain loss may induce farmers to dispose of most of the grain they produce immediately after harvest, even if they have to repurchase at some future date.

[22] See http::/www.unu.edu/unupress/food/8f012e/8f012E0b.htm

Obviously, they then are subject to interseasonal price discrepancies (9), which would affect the level of farmers' income and therefore their access to food (2).

Hence, the level of household food security may be affected directly by the size of the physical loss of grain or indirectly by income lost when grain prices decline as a result of deterioration in quality or inter-seasonal price variations.

5. Hypotheses

Given resource endowments and output levels, it could be hypothesized that poor post-harvest grain management practices would result in a low level of food security through(1) the output effect, that is, a reduction in grain *availability* due to physical losses and involuntary sales, and
(2) the income effect, that is, a reduction in *access* to food because prices received when grains are sold immediately after harvest are lower or prices are higher when grains are repurchased, or the quality of grains deteriorates so that they fetch lower prices.

The following specific hypotheses were suggested to guide the research work.

(a) Farmers' perception of risk about post-harvest grain loss influences their marketing behavior, that is, it explains why farmers dispose of most of their output immediately after harvest and at cheaper prices, eventually producing suboptimal outcomes, which result in a low level of household food security.
(b) Farmers' choices of post-harvest grain management practices are conditioned by resource endowment patterns (for example, liquidity constraints), which determine the magnitude of losses. Hence, better-off farmers are likely to choose better post-harvest grain management practices than the poorer ones.
(c) The potential risk associated with physical post-harvest grain losses is more important than the potential risk associated with the market in explaining farmers' post-harvest grain management practices and their impacts on food security.
(d) Intercrop differences in post-harvest risk of loss are important factors determining the share of marketed surplus of food grains; that is, the crops that are mainly marketed immediately are those for which the risk of post-harvest loss is highest.

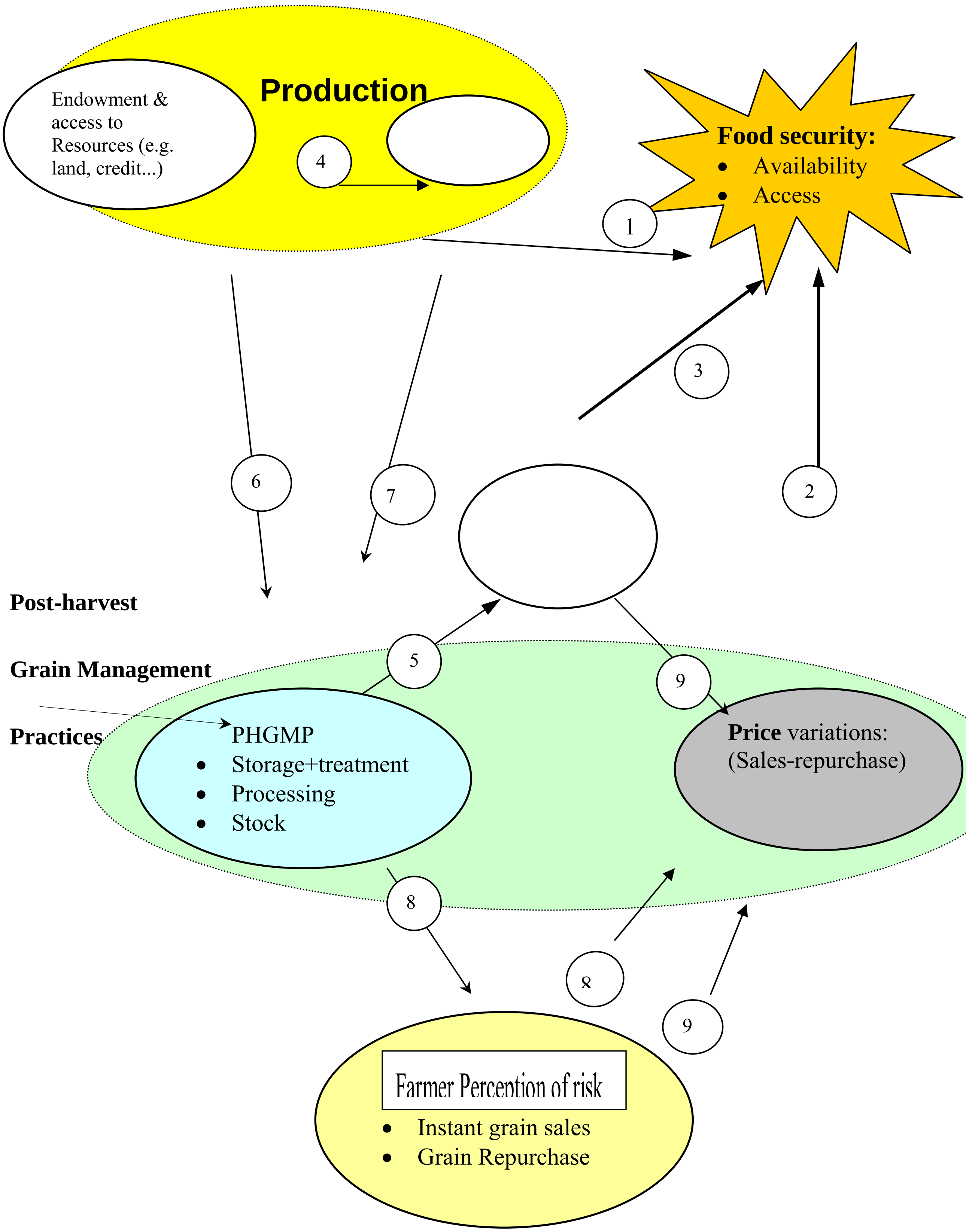

Figure 1. A Conceptual Framework: Post-Harvest Grain Management as a Determinant of Household Food Security Levels

6. Methodology

6.1. Data Requirements and Collection

The study is basically a household-level analysis. Relevant secondary information was collected from the archives of various organizations (for example, the Central Statistical Authority). Field surveys were conducted to collect primary data. The set of information collected included resource endowment patterns, socioeconomic characteristics, production, post-harvest infrastructure, inventory of storage, processing, stock-management practices, losses, food availability, sales, purchases, prices, functions, and importance of rural institutions (formal and nonformal) such as credit, saving, and cooperatives.

Three areas that mostly produce maize (Bako, west of Addis), wheat (Chilalo, south of Addis), and teff (Ada, east of Addis) were included in the study for the obvious reason that these crops are the major food items in the country (together they would constitute two-thirds of total calorie intake). East Shewa and Arssi and, to some extent, Bako (in western Shewa) occupy an important place in the history of Ethiopia's agricultural development for several reasons. First, the regions are better endowed than most with good agricultural potential. Rainfall has been adequate and its distribution normal with reasonable stability, compared with many other areas in the country. Second, they are the most accessible areas within the country. Third, these are among the few surplus-producing regions. Fourth, partly due to the above factors and their proximity to major urban centers, these regions have served as testing sites for a series of "rural development" ventures. Fifth, they tend to exhibit a distinct cropping pattern marked by a relatively high degree of intensification, concentration, and market orientation. The tendency to specialize in the production of distinct cereals is apparent. Their ratio of marketed surplus is one of the highest in the country.

Although the target sites were selected because of their specialization in the three crops (maize, wheat, and teff) , data were collected for all other crops grown in the area and the analysis was done accordingly. Two peasant associations (PAs) from each region were purposively considered, making a total of six PAs. These are Oda-Jila and Gode-Finchama in Chilalo Keteba and Ude in Ada; and Sadan-Kite and Dembi-Gobu in Bako. Each PA provided a list of peasant households, which served as a sample frame for stratification purposes and ultimate selection of sample households. Peasant households were randomly selected after the food-deficit (or poorer) ones were excluded. This is because post-harvest grain management assumes the existence of surplus production over and above immediate consumption, which the poorer households do not have. Fifty peasant households from each PA were selected; hence, a total of 300 households were included in the survey.

Primary data were collected using a questionnaire, interview guides, participatory discussions with focus groups, and informants. Six enumerators (two for each area) were employed and trained to administer the questionnaire. The researchers undertook a series of discussions with the focus groups and informants and supervised the enumerators.

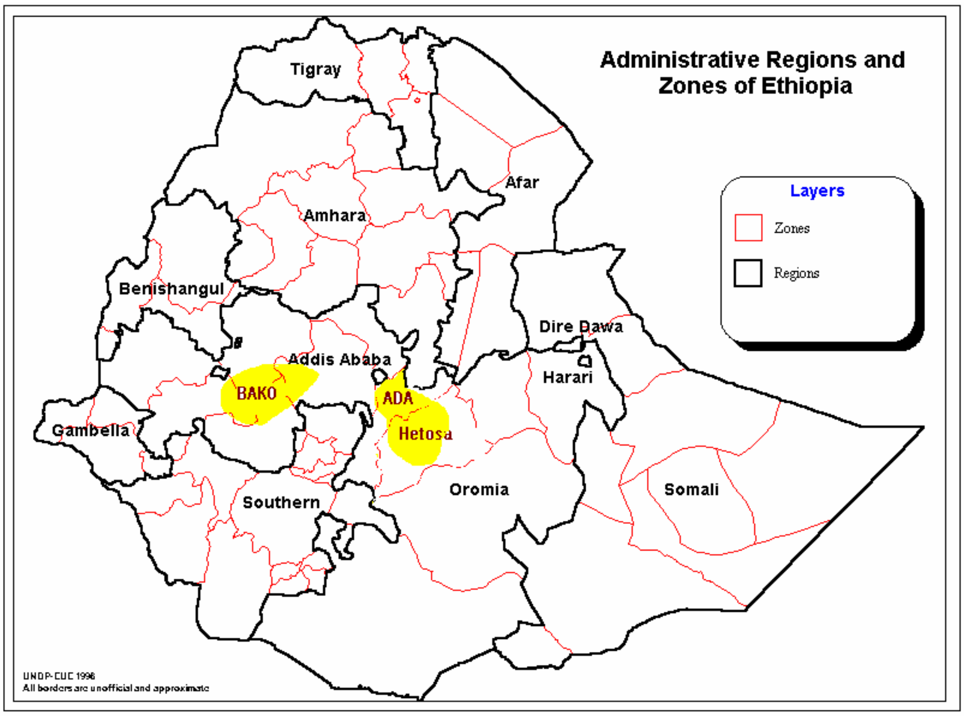

Figure 2: The Study Areas (shaded areas are Bako, Ada, and Hetosa)

6.2. Methods of Data Analysis

Both descriptive (qualitative and quantitative) and econometric methods of data analysis were employed. Farmers were asked to describe in detail their post-harvest grain management systems, as well as production levels, past post-harvest grain losses and their causes, and traditional loss-minimizing strategies, among others.

We wanted to know what factors influenced farmers' grain marketing behavior, in particular, their decision to dispose of most of their grain produce immediately after harvest, and if the risk of post-harvest loss is significant in explaining such behavior. Also we wanted to know if, and in what ways, these decisions are related to household food security issues. Hence, the dependent variable is *farmer's instant disposal behavior* ***(D_i)***; while the explanatory variables would be risk of post-harvest grain loss ***(z)*** characteristics of the post-harvest grain management practices (***m***), grain prices (***P***), household characteristics (***W***), and farmers' resource endowments (***x***).

Taking an extreme example, a farmer may decide either to dispose of all of his or her produce during the first quarter immediately after harvest (when prices are at their lowest levels) or to wait until later, in which case sales during the first quarter would be zero. Hence, the utility associated with each alternative is a function of the independent variables. Denoting U_{i1} and U_{i0} as the ith farmer's indirect utilities associated with instant disposal and late disposal, respectively, and assuming a linear function (for ease of presentation, taking only two sets of explanatory variables ***Z*** and ***W***), we have

(1) $$U_{io}=\alpha_0+\beta_0 Z_{i0}+\gamma_0 W_{i0}+\epsilon_{i0},$$ and

(2) $$U_{i1}=\alpha_1+\beta_1 Z_{i1}+\gamma_1 W_{i1}+\epsilon_{i1}.$$

The i[th] farmer tends to dispose of all of his or her grain immediately after harvest if $U_{i1} > U_{i0}$ and to delay sales to a later season (in this case, beyond the first quarter after harvest) if $U_{i1} < U_{i0}$[23]. Hence, the probability that the i[th] farmer disposes of all of his or her produce during the first quarter immediately after harvest can be given by:

$$P(D_i=1) = P(U_{i1} > U_{i0})$$

$$= P[(\epsilon_{i0}-\epsilon_{i1} < \alpha_1-\alpha_0 + \beta(Z_{i1}-Z_{i0}) + \gamma(W_{i1}-W_{i2})];$$

(3) $$P(D_i=1) = F(\alpha_1-\alpha_0) + \beta(Z_{i1}-Z_{i0}) + \gamma(W_{i1}-W_{i2}),$$

where F is the distribution function of ϵ_{i0}-ϵ_{i1}. If a normal distribution is assumed for ϵ_{i0}-ϵ_{i1}, then the model turns out to be a probit or logit one (Amemiya 1985; Maddala 1988).

Expressing D_{it} in terms of the proportion of the volume of sales during the first quarter after harvest (S_{it}) to total sales during the year (Q_{it}), that is, $D_{it} = S_{it}/Q_{it}$, one could note that the distribution of D_{it} is continuous but tends to behave like a probability; its value tends to lie between zero and one (that is, $0 \leq D_{it} \leq 1$). However, it is also conceivable for D_{it} to assume negative values, in cases where some farmers might purchase grains (instead of selling) during the first quarter after harvest. In fact, this implies that the latent variable can take negative values, in which case the Tobit model is more appropriate to use.

The Tobit model is given by:

(4) $$D_{it} = \begin{cases} \alpha + \beta Z_{it} + \gamma W_{it} + u_{it}, & if\ D_{ti} > 0; \quad i = 1, 2, 3, ..., n, \\ 0 & if\ D_{it} \leq 0 \end{cases}$$

The problem with the estimation of this model is that Z_i cannot be observed since it is the expected risk of post-harvest grain loss. Hence, specification of a model that explains how farmers form expectations on the bases of actual and past post-harvest grain losses and other observable variables is essential. Theoretically, this learning process in which farmers adjust their expectations as a function of the magnitude of the mistakes they made in the previous period can be expressed as a weighted sum of all past post-harvest grain losses with a geometrically declining weight.

(5) $$Z_{it}^{e} = \sum_{i=1}^{\infty} \beta_i Z_{it-1}.$$

These models are called distributed lag models of expectations since they consider the entire past history of the decisionmaker with respect to the target variable. If β_i is geometrically decreasing, we can write

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23 There could be indecision if $U_{i1} = U_{i0}$, but the probability of this is zero if $\epsilon_{i1}$and ϵ_{i0} are continuous random variables (see Amemiya 1985).

(6) $$\beta_i = \beta_0 \lambda^i, \quad 0<\lambda<1.$$

The sum of the infinite series is $\frac{\beta_0}{(1-\lambda)}$, and if this sum is equal to 1, then we should have $\beta_0 = 1-\lambda$. Thus we get

(7) $$Z_{it}^e = \sum_{i=1}^{\infty}(1-\lambda)\lambda^i Z_{it-1}.$$

A further manipulation of equation (7) implies that

(8) $$Z_{it}^e - \lambda Z_{it}^e = (1-\lambda)Z_{it-1}.$$

We can use equation (8) to eliminate the unobserved Z_{it}^e and estimate the resulting equation. That is, lagging equation (5) by one time period and multiplying throughout by λ, we get

(9) $$\lambda D_{it-1} = \alpha\lambda\beta\lambda Z^e_{it-1} + \lambda\gamma W_{it-1} + v_{it-1}.$$

Subtracting equation (9) from equation (5) and using the definition of adaptive expectations model as given in equation (8), we get

(10) $$D_{it}^* = \alpha' + \lambda D_{it-1} + \beta' Z_{it-1} + \lambda W_{it} - \lambda' W_{it-1} + u_{it},$$

where $\alpha' = \alpha(1-\lambda)$, $\beta' = \beta(1-\lambda)$, $\gamma' = \gamma\lambda$, and $u_t = v_6 - \lambda v_{t-1}$.

Hence, the Tobit equation that will be estimated becomes

(11) $$D_{it} = \begin{cases} D_{it}^*, & if\ D_{it} > 0; \quad i = 1, 2, 3, ..., n, \\ 0 & if\ D_{it} \le 0 \end{cases}$$

In fact, Z_i could also be disaggregated into a risk of loss in quantity and prices, and the relative importance of either of these elements of risk in explaining instant disposal of grains by farmers could be detected. It is important to note that a higher level of D_{it} reduces the household level of food security, especially if this is the result of some involuntary process this is because it does not make any economic sense to dispose of a larger proportion of one's produce immediately after harvest at the lowest price level.

6.3 Definition of Variables

Nine explanatory variables are included in the Tobit regression estimation. Each explanatory variable is described below. Appendix Table 1 presents the mean values of continuous explanatory variables and the proportion of 1s for the dummy explanatory variables.

Table 2: Description of Variables

Variable	Code	Definition/expectation	Expected sign
Household size	**FSIZE**	High demand for cash to meet nongrain or nonagricultural consumption needs of the household members triggers larger sales during the first quarter.	**Positive**
Gender	**SEX**	A dummy variable, which takes a 1 if the household head is male and 0 otherwise. It is expected that male-headed households tend to market their crops earlier than female-headed households.	**Positive**
Education level	**EDUC**	The highest level of formal education achieved by a member of the household. Education is expected to influence the decision to sell grain in such a way that those households with higher education levels are hypothesized to demonstrate better- informed sales decisions and vice versa. Proportion of grain sales during the first quarter is expected to be lower for those households with better education.	**Negative**
Chemical application.	**CHEM**	A dummy variable that takes on a value of 1 if a household used chemicals to reduce post-harvest grain loss and 0 otherwise. Application of pesticides is expected to reduce the risk of post-harvest grain loss, thus reducing instant grain sales.	**Negative**
Storage capacity	**STCAP**	Estimated total nonbag storage capacity owned by households. With larger capacities of granaries, the proportion of grains to be sold during the first quarter is expected to be less.	**Negative**
Livestock ownership	**TLU**	Total livestock owned by households expressed in terms of Tropical Livestock Units. Standard conversion factors have been used for different categories of livestock (see Appendix Table 2). Livestock ownership is expected to reduce instant crop sales since households may resort to livestock (and/or livestock products) sales to meet cash needs.	**Negative**
Expectation of losses	**EXPLOSS**	The proportion of output that farmers expect to lose due to storage pests (or other factors) if grain crops were to be stored until prices rise substantially (in this case until the third quarter). It is hypothesized that fear of risk of loss might cause farmers to sell their crops	**Positive**

		sooner rather than later.	
Intercrop differences	**PRICDIF**	The difference in average prices of grains that prevailed between the third quarter (July to September, when highest) and the first quarter (January to March, when lowest) measured in birr per kilogram[24]. On the one hand, this variable captures the market risk element; i.e., as the difference increases farmers postpone their sales until later, when prices actually get higher; and conversely, as the price difference narrows, farmers prefer to sell their crops sooner, since waiting is associated with a higher risk premium, especially since post-harvest grain loss could be larger. However, since the price differences are the same for each location (not household-specific), each household's risk perception is not captured; therefore, this interpretation might be misleading. On the other hand, since price differences are largest for teff and smallest for maize, this variable might capture the intercrop differences (could be considered crop dummies). In this case, the variable takes on a negative coefficient, suggesting a tendency toward instant sales for Bako and delayed sales for Ada (capturing the intercrop differences in susceptibility to post-harvest grain losses).	**Positive**
Liquidity constraints	**TAXLOAN**	The total monetary value of grains sold to cover dues such as repayment of input loans and/or land taxes. It is expected that farmers' instant crop sales are largely involuntary but triggered primarily by the need to pay the government for input loans, land taxes, or the like.	**Positive**

[24] Since we could not generate grain price data at the household level, we used the average of grain wholesale prices for each location. Prices of the major crop in each location are considered since farmers use these crops as "cash" crops (teff for Ada, wheat for Hetosa, and maize for Bako.

7. Empirical Results

7.1. Description of Survey Findings

7.1.1. Farm Resources and Grain Production

Grain production in Ethiopia is almost entirely based on rain-fed agriculture and is characterized by a dominant harvest (*meher*)—generally around November and December—and a secondary harvest (*belg*)—around May and June. Of course, production cycles vary among different agro-ecological zones. The study areas depend on *meher* production of cereal crops.

Land is the major farm resource in the study areas, and it can be accessed in two ways: via land allocations by PAs and through informal land markets. About 98 percent of the sample households were alocated some land by their PAs.] In addition, 51 percent of the households also acquired some of their farm plots through sharecropping or rental arrangements. Few of the sample households (5 percent) shared or rented out their farm plots during the year surveyed. The small proportion of farmers who shared out their land reflects the bias in the sampling procedure toward relatively better-off farmers, who usually seek additional land. As discussed in the methodology section, the selection of better-off farmers was deliberate because the basic research problem, post-harvest grain loss, assumes that there is surplus production, and therefore, surplus-producing farmers.

On average, cultivated area per household is about 2.7 hectares. This is on the high side for the area, which perhaps reflects the importance of informal land markets. That is, since the farmers included in this study are relatively better off, they tend to have leased in land from resource-poor farmers. Significant variations exist among the three sites vis-à-vis the average area allocated to production of different crops. Table 3 shows the cultivated area under major crops included in the study during the 2002/03 main harvest period. Grains, largely wheat, teff, and maize, take the lion's share of total cultivated land: 65 percent in Hetosa, 47 percent in Ada, and 75 percent in Bako.

Livestock is the other important asset owned by the sample households. The study areas are characterized by mixed farming and almost all sample households own some livestock. Various types of animals are reared including large and small ruminants, pack animals (equines), and poultry. An average livestock holding, excluding poultry, is 11 animals per household, which is equivalent to 8.5 tropical livestock units (TLU).[25] Almost every household owns at least two milking cows and three oxen, which again reflects the relatively better resource endowments of the sample households.

Livestock is an important source of income for the sample households. More than one-half of the households sell either livestock or livestock products to generate cash revenue. On average, a household generated about 460 birr from the livestock subsector in the year under consideration[26]. Households enumerated various reasons for selling livestock and their products; the main ones included repayment of input loans (28.1 percent of households) to

[25] TLU is a standardized measure of livestock numbers. (see Abebe 2000).

[26] This amount doesn't include the revenue generated indirectly from livestock use, for instance, by renting out draft animals to others.

replace old animals (19 percent of households), to purchase household equipment and furniture (14.3 percent of households), and to cover expenses related to education and health (9 percent of households).

Table 3. Average cultivated land area (hectares) of major crops per household

Crops	Hetosa		Ada		Bako	
	Area	Percent of total	Area (ha)	Percent of total	Area (ha)	Percent of total
Teff	0.052	1.79	1.17	46.54	0.20	7.69
Wheat	1.88	64.56	0.80	31.82	0.00	0.00
Maize	0.27	9.27	0.024	0.95	1.95	75.00
Sorghum	0.14	4.81	0.0	0.00	0.23	8.85
Other crops	0.57	19.57	0.52	20.68	0.22	8.46
Total	2.91	100.00	2.51	100.00	2.60	100.00

7.1.2. Post-harvest Grain Management Practices and Losses

(i) Farmers' Grain Management Practices

Unlike mechanized farms where mowing and threshing can be undertaken simultaneously, grain harvesting on these farms involves mowing of crops using sickles and threshing by letting a group of animals trample upon then on level ground until the grains and the shaft are separated. Harvesting of maize is different in that the ears are removed by hand. Several days may elapse before crops are threshed; that is, crops stay piled for some time either around the homestead or *in situ* before threshing. In many cases, losses during the harvesting process are significant (as a result of attacks by rodents and pests, moisture, livestock, and the like.).The length of time that crops are kept piled up varies among crops. Usually, crops that are susceptible to loss (such as pulses) do not stay long, while other crops (such as teff) may be piled up for a long time. The amount of time that crops are piled up also varies depending on the household's food and financial requirements: those with immediate needs would thresh their crops at once.

Farmers use various methods and types of facilities to store their crops after they are threshed or shelled. Maize may be stored either shelled or unshelled. In the latter case, maize is shelled manually a little at a time as required for consumption or sale. Hired machines are used to shell maize, especially when production is large. The traditional grain stores identified in the study areas include *gotera* (grain pits), bags (made of polyethylene, sisal, or goat skin),[27] and earthen pots. More than 70 percent of the respondents use polyethylene bags and sacks made of sisal, while about two-thirds use *gotera* (Table 4). For storing large quantities for longer periods, farmers prefer *gotera*. Some farmers also use pots and small granaries entirely made of mud. Slight variations have been observed among the three sites vis-à-vis the proportion of farmers using each type of storage: *gotera* are widely used in Bako, whereas bags (or sacks)

[27] This traditional container is commonly known as a *silicha,* and it is estimated to hold 50 to 60 kilograms of grain. Making *silicha* is a special skill, and care is required when the goat is skinned.

are commonly used to store grain in the other two sites, perhaps suggesting that farmers store grains only temporarily in Ada and Hetosa.

Table 4. Type of stores used (by number and percent of respondents)

Type of Storage	Hetosa		Ada		Bako		Total	
	No.	%	No.	%	No.	%	No.	%
Bags/ sacks	93	94.9	84	84.0	33	33.0	210	70.5
Gotera	73	74.5	49	49.0	80	80.0	202	67.8
Pots	14	14.3	9	9.0	5	5.0	28	9.4
Underground pits	1	1.0	-	-	-	-	1	0.3
Others	4	4.1	32	32.0	18	18.0	54	18.1

Farmers acquire their grain stores in different ways. The majority of *gotera* users construct them, reflecting a weak dependence on markets. In most cases, *goteras* are constructed from flexible materials (such as bamboo trees) and are mud-walled and thatch-roofed. Although not common, farmers could purchase these traditional granaries from local markets. The average owner estimated the monetary value of the *gotera* at about 62 birr, with figures ranging from 10 to 500 birr. The value of a store depends upon its capacity and the materials used for its construction. Polyethylene bags and sacks (made of sisal) are commonly purchased from local markets. In fact, farmers use fertilizer bags to store grains after the bags have been used. The average estimated monetary value of these containers is 3.25 birr. We have also observed some higher figures (up to 35 birr) probably indicating the value of *silicha*, which are relatively durable. Other small traditional granaries are mostly self-made. These are usually used to store seeds or grains produced in small quantities and their estimated values range from 4 to 30 birr.

Table 5 shows the number of grain stores owned by peasant households and their storage capacities. The average storage capacity of the sample households is 3.27 metric tons, enough foodgrain storage for one, or possibly two, production seasons. If all kinds of storage mechanisms (temporary and fixed) are considered,[28] few households can store more than 5 metric tons of foodgrain. If, on the other hand, bags and sacks are excluded from the analysis, the average storage capacity per household could be reduced to 2.52 metric tons. This is quite low compared with the average volume of total grain produced (4.39 metric tons), indicating that storage is constrained in the survey areas. To put it in a different way, about 79 percent of the farm households did not have adequate fixed stores for their produce. A disaggregated analysis by site shows a more detailed picture (Table 6). While fixed stores could absorb more than three-quarters of total output in Hetosa and Bako, these are not widely used in Ada, possibly because teff, the major crop in Ada, is relatively less susceptible to storage pests (particularly weevils). Hence, it can be readily stored in bags, or even sold at once. This is clearly not the case in Hetosa and Bako, where the bulk of grain production is wheat and maize, respectively, which are more susceptible to storage pests.

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[28] Strictly speaking, bags and sacks are not permanent grain stores. Rather they are used to store grains,that will be sold in the market quickly.

Table 5. Number and capacity of grain stores owned by households

Storage type	Number		Capacity (MT)	
	Mean	Maximum	Mean	Maximum
Gotera	1.6	8	2.105	26.0
Bags/sacks	12.9	200	0.739	11.0
Pots	0.5	7	0.025	2.5
Others	2.7	96	0.385	20.0
Total			**3.27**	**37.0**

Table 6. Storage capacity compared with total grain production

Study Sites	Total Capacity (MT)				Total output (MT)
	All Stores	Percentage[a]	Fixed Stores	Percentage[a]	
Hetosa	4.74	102.6	3.52	76.2	4.62
Ada	1.69	39.4	0.78	18.2	4.29
Bako	3.41	80.2	3.35	78.8	4.25
All Sites	**3.27**	**74.5**	**2.54**	**57.9**	**4.39**

[a]Storage capacity as a percentage of total grain produced.

Grain losses could arise from poor post-harvest handling or from production beyond the capacity of available stores or both. When production exceeds total storage capacity, two options are available to solve the problem: instant disposal of the excess produce (through sales or loans.), or increase of storage capacity. If grain markets are demand-constrained, or supply is price-elastic, as it is in the case of grains, immediate sale after harvest will have a price-reducing effect. Hence, this option seems to be less preferable for producers. At the study sites, however, about two-thirds of the sample farmers resort to selling their grains whenever production is in excess of their storage capacity.

Grains may be stored outside as well as inside residential houses. The majority of the respondents (71.6 percent) reported that they locate their stores inside their homes to protect grains from theft and moisture. Others store grains outside because they believe the outdoor environment provides better aeration, keeping crops for longer periods without damage from insect pests. Locating grain stores outside the home also has another advantage: it frees up space in the living room that would otherwise be crowded with grain, especially after harvest.[29] Since *gotera* occupy a larger space, they are commonly located outside.

(ii) Post-harvest Grain Losses

The majority of the farmers (93.3 percent) perceive an imminent risk of grain loss from attack by storage pests or other factors if they store their crops for longer periods. The minimum expected average amount of loss per household for all grain crops is about 150 kilograms for Ada (where teff, the least susceptible crop, isdominant), whereas the maximum expected

[29] In most cases peasants live in traditional huts having a single room in which the whole family dines and sleeps; the same room may also be used to prepare food.

average amount of loss per household is more than 800 kilograms for Bako (where maize, the most susceptible crop, is dominant). Also as can be observed in Figure 3, there is large variation about the median in post-harvest grain loss in Hetosa and Bako, as compared with Ada, again indicating the intercrop differences in post-harvest grain losses. In some cases, the magnitude of loss even goes as high as 2,000 kilograms.

The respondent farmers reported to have actually lost large quantities of their produce to various factors (Table 7a). The average actual loss per household (as opposed to expected loss) was about 500 kilograms of total grain output during the previous year, which is equivalent to 12 percent[30] of the average total grain production of the sample households. Farmers in Bako reportedly lost about 700 kilograms of crops and those in Hetosa, 620 kilograms, due to post-harvest damage, while the figure for Ada was much less. Of course, these variations reflect differences in cropping patterns among the three sites and, therefore, the higher degree of susceptibility for maize and wheat than for teff. The reported amount of loss is quite substantial, underscoring the importance of not only raising yield levels, but also ensuring that all of the grain produced reaches consumers' tables without loss. Hence, yield-enhancing interventions cannot be considered in isolation from those that minimize post-harvest grain losses.

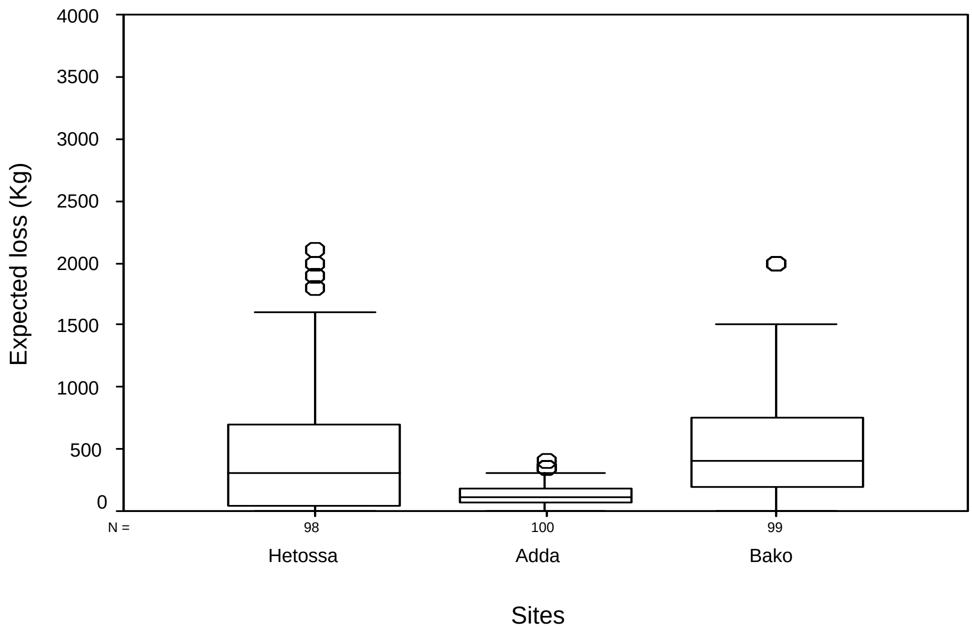

Figure 3. Distribution of expected loss if grains are stored until the fourth squarter

Table 7a. Estimated grain loss during 12 months preceding the survey (kgs. by site)

Study Areas	Mean	SD	CoV
Hetosa	618	438.6	0.71
Ada	237	308.9	1.30
Bako	707	1118.6	1.58
All Sites	**520**	**744.0**	

[30] Other studies (Coursey and Proctor (n.d)) have reported wheat loss (by weight) ranging from 8 to 52 percent for India, 6 to 19percent for the Sudan, and 15 to 20 percent for Brazil.

Table 7b.Estimated grain loss during 12 months preceding the survey (kgs. by crop)

Major Crops	Mean	SD	CoV
Wheat	243	360.0	1.48
Teff	106	179.7	1.70
Maize	501	930.0	1.86
All Crops	**520**	**744.0**	

As can be seen in Table 7b, maize is the most affected crop, that is to say, on average a maize-producing household lost 501 kilograms of maize during the 12 months proceeding the survey period. The average loss by wheat producers was 243 kilograms. Teff, as expected, was less susceptible to post-harvest loss than wheat and maize. On average, the sample households lost about 106 kilograms of teff.

Taking the nominal average producer price[31] that prevailed during the year 2002 for the three crops, the amount of loss in birr would be 244, 185, and 360 for wheat, teff, and maize producers, respectively. As can be seen, (tables 7a and b), the variations narrowed down to price differentials; teff and wheat fetched higher prices than maize. It can also be seen that estimated grain losses for the three crops are less than the estimated losses for all crops in the region ; perhaps such variations suggest that post-harvest losses of other crops such as pulses might have been large.

Defining the shelf life of grain crops as the number of months in which they can be stored without loss in quantity or quality, shelf life varies depending on a number of factors: the type of storage infrastructure, type of crop, weather conditions, treatments made to reduce loss, among others. In the study sites, grain crops can reportedly be stored on average for about 7 months without loss. Of course, the shelf life may increase to about 10 months if the grains are treated with chemicals. The sample farmers reported that grains, particularly maize, could turn into powder in a few months due to weevils if the grain was not treated with insecticides. The longest average shelf life was reported for teff (with or without chemical treatment) and the smallest was reported for maize (without chemical treatment) (Table 8). It is also apparent from the figures that maize can only be stored for a relatively short period of time (half ayear) even if it is treated with chemicals.

Table 8: Estimated shelf life of selected crops with and without chemical treatment

Crop	Estimated Shelf Life (Months)	
	With chemical treatment	Without chemical treatment
Teff	Not applicable	19.0
Wheat	11.5	6.4
Maize	6.9	2.8

[31] Producer prices were computed from various CSA reports; average producer prices for 2002 for wheat, teff, and maize were 100.2, 174.6, and 71.9 birr per 100 kilograms.

Among the reported causes of the post-harvest losses experienced by the peasant households are attacks from weevils and rodents and moisture or growth of molds, with weevils the most commonly reported cause (Table 9). Rodents, moisture, and molds are also important in areas such as Hetosa and Bako.

Table 9. Causes of grain loss identified by respondents (percent)

Causes	Hetosa **(N=98)**	Ada **(N= 100)**	Bako **(N=100)**	All Sites **(N=298)**
Rodents	28.2	18.9	59.1	30.8
Weevils	90.4	82.2	95.3	87.7
Moisture/molds	22.6	11.4	45.7	22.5
Others	1.1	1.9	9.4	3.3

Note: Figures indicate percent of respondents who reported each cause of grain losses.

The most important preventive techniques used by the surveyed farmers were chemicals and aeration (Table 10). The majority of the sample farmers (83.2 percent) used chemicals to reduce grain losses from pest attacks, especially on maize and wheat, which are susceptible to weevils. In addition, a quarter of the farmers reported using aeration. Grain management practices such as lending to others and selling and repurchasing later were not widely used. Some farmers also reported that they used various indigenous methods to reduce post-harvest grain losses due to pest attack. For instance, in Bako and Hetosa, grains (especially maize and wheat) are mixed with chili peppers to repel storage pests. Blaum and Abate (2002) also report on this practice. However, the effectiveness of such practices has yet to be confirmed by scientific research.

Table 10. Techniques used by farmers to reduce grain losses

Techniques Used	Percentage of households (N = 298)
Aeration	25.1
Use of Chemicals	83.2
Sell and repurchase latter	0.8
Lend to others	1.1
Others (including indigenous techniques)	8.5

Farmers were asked if they knew techniques other than those they have been practicing so far. The objective was to explore whether farmers have other options by which they could reduce grain losses. While the majority (71.4 percent) replied that they did not know any other techniques, nearly 30 percent reported that they were aware of the existence of various post-harvest grain management techniques, but they did not apply them for various reasons. For example, more than 50 percent of the interviewed farmers did not utilize those “other” techniques because they perceived the methods they were already using to be more effective in reducing grain losses.

7.1.3. Grain Marketing Practices and Patterns

Ninety-nine percent of all farmers reported that they sell some crops under normal conditions. Some farmers also purchased grain crops; about 40 percent of the respondents purchased crops using their previous savings. Crops are usually sold in a staggered pattern across the quarters of a year. Table 11 shows the share of total grain output produced that is marketed. The share of marketed surplus to total output for Hetosa was 40 percent; for Ada, 63 percent; and for Bako, 48 percent. With the exception of Ada, more than one-half of total production does not reach the market; it is consumed within the farm household. That farmers do produce a large assortment of crops and sell some proportion (not most) of it reflects the extent to which production is oriented toward household consumption rather than sale. However, the proportion of total production that is marketed—the extent to which a given crop resembles a "cash crop"—varies among crops as well as sites. A considerably higher proportion of total production of the major crops, wheat, teff, and maize, was marketed, compared with other crops in Hetosa, Ada, and Bako. Obviously, these three crops are dominant in terms of area cultivated as well as output. For example, 65 percent of the total cultivated area in Hetosa was allocated to wheat production, and about 42 percent of the output was marketed. Similarly, of the total cultivated land in Ada, 47 percent was allocated to teff, while 32 percent was allocated to wheat production; the proportion of teff that was marketed was 67 percent and the share of wheat marketed was 57 percent. In Bako, 75 percent of the land cultivated was allocated to maize, and 44 percent of the output was marketed.

Table 11 Percentage of crops marketed of total output produced

Crops	Hetosa	Ada	Bako
Teff	0.0	67.0	3.9
Barley	0.0	14.1	---
Wheat	41.9	57.4	---
Maize	5.2	0.0	44.0
Sorghum	1.5	---	12.6
Horse bean	1.8	14.6	0.0
Field pea	1.8	11.2	---
Chickpea	0.0	47.4	---
Others	0.0	31.9	29.1
All crops	39.7	63.2	48.3

On aggregate levels, the proportion of actually marketed output during the first quarter of 2002 was about 51 percent of total marketable surplus for the entire year. The average percentage of crops sold declines as one moves from the first quarter to the fourth quarter (Figure 4a). To the contrary, the producers' prices tend to rise as one moves from the first quarter through to the third and, in some cases, even during the fourth quarter (Figures 4b–4d).

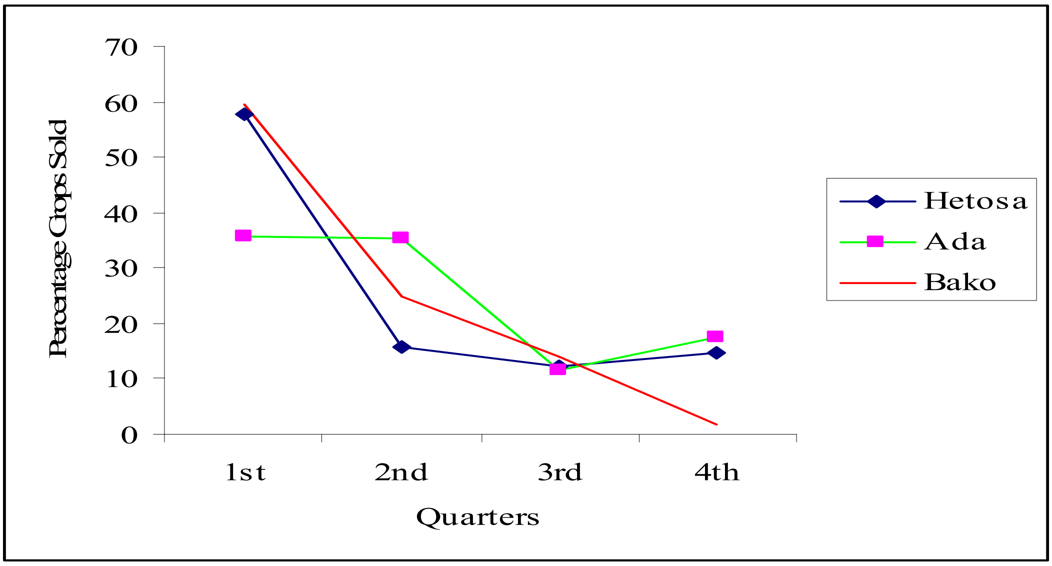

Figure 4a. Movement of crop sales by quarter (percentage of total sales)

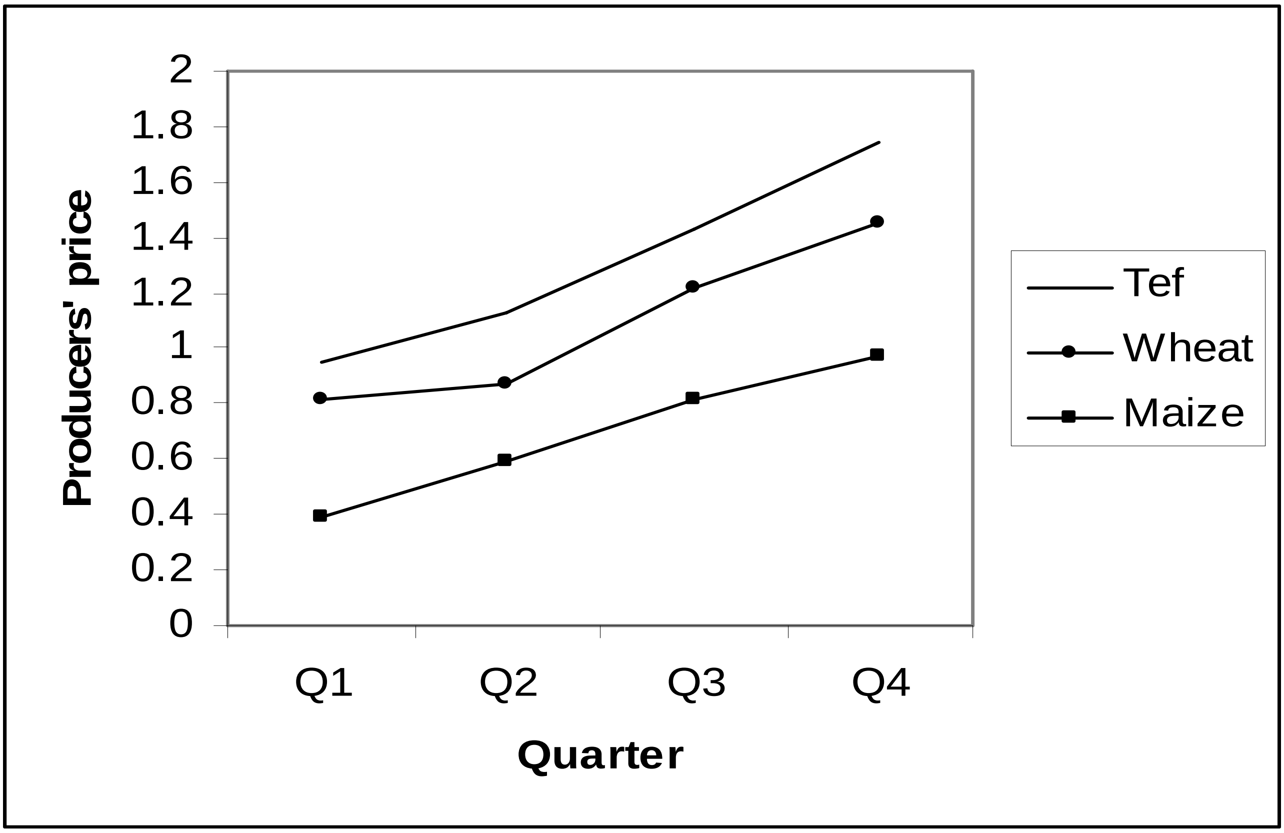

Figure 4b. Movement of producers' prices of selected crops (2002 Bako area, 2002)

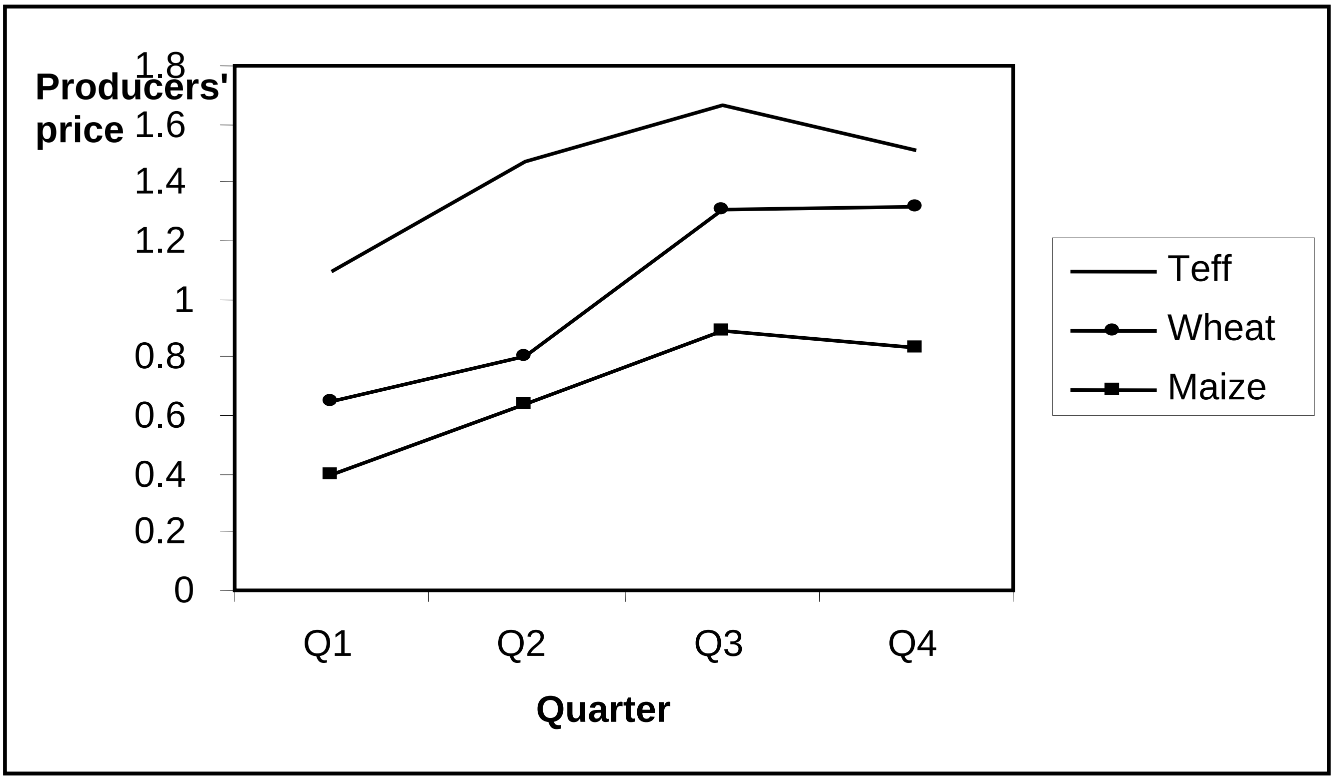

Figure 4c. Movement of producers' prices of selected crops (Hetosa area, 2002)

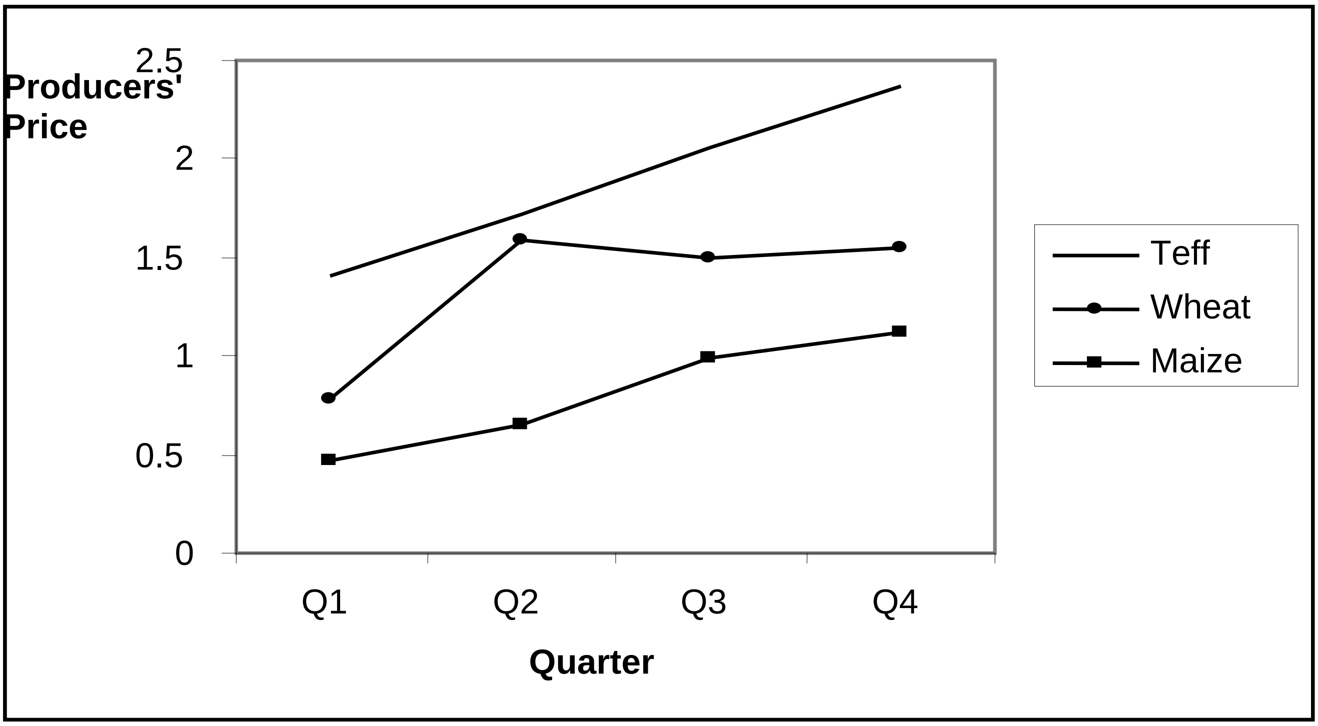

Figure 4d. Movement of producers' prices of selected crops (Ada area, 2002)

Also, the proportion of crops sold during the first quarter varies considerably among the three sites. . The average figures are higher for Hetosa and Bako than for Ada, indicating that farmers in the former two sites sold the bulk of their crops immediately after harvest (Table 12). It is worthwhile to note that farmers are unorganized in their sales decisions; hence they lack bargaining power to deal with traders who have better resources, information, and coordination to influence market outcomes.

Table 12. Crops sold as a percentage of total crop sales in a year (by quarter)

Quarter	Percentage of Crops Sold			
	Hetosa	**Ada**	**Bako**	**All Sites**
1st Quarter (January-March)	57.6	35.8	59.5	50.9
2nd Quarter (April-June)	15.9	35.4	24.9	25.5
3rd Quarter (July-September)	12.3	11.4	13.9	12.5
4th Quarter (October-December)	14.6	17.6	1.8	11.1

Farmers knew about the general pattern of seasonal price fluctuations. The farmers reported that they were aware that prices would increase after the first quarter, especially during the lean season. Why then would they want to sell a large proportion of their marketable surplus immediately after harvest when prices are the lowest in the year?

One important reason could be the high demand for cash during the first quarter. As indicated earlier, that particular season is the time when farmers need money to settle financial obligations including repayment of loans and taxes and to meet social obligations (such as marriage, religious festivals, and other ceremonies). For instance, the interviewed farmers reported that about 33 percent of the gains from grains marketed during the first quarter went to finance repayment of input loans or to pay land taxes or both.

The other important reason might be fear of the risk associated with post-harvest grain losses. The majority of the interviewed farmers viewed post-harvest problems as matters of grave concern.

The commonly held view, which happens to be true most of the time, is that crop prices will be lowest during the first few months following harvest; then they will rise monotonically until they reach the maximum during the months of July and August, after which they start to decline in expectation of a new harvest in a few months' time. But, what happens to the pattern of prices following a bumper harvest? Prices monotonically decline during the months in which they normally peak. They may be depressed even further if another good harvest is expected. This is what actually happened in 2001(see Figure 5 a, b, and c).

The year 1999 was followed by expectation of a good harvest in 2000. Prices increased consistently from January until September for all crops; then they started to fall. Maize prices dropped earlier than wheat and teff prices because the harvest season is earlier for maize. But the decline of prices after October in all crops is associated with expectation of the next harvest in 2000.

Now compare this with what actually happened to prices in 2001. It is the reverse of the previous story. Instead of rising, prices declined steadily, only picking up after October when it became known that a bad harvest seemed likely the following season. In fact, the harvest was so bad that much of the country faced famine in 2002/03. This illustrates the extent of market failures. Crises occur both when the harvest is good and when it is bad. On the one hand, when the harvest is good, especially when it is matched with high expectations for the next season, grain prices tend to be depressed. Storing grains might not be advisable,. Since prices may not get better even during lean seasons. On the other hand, during normal years, storing of grains until the third quarter might pay, if the risk of grain loss is minimized below market risks.

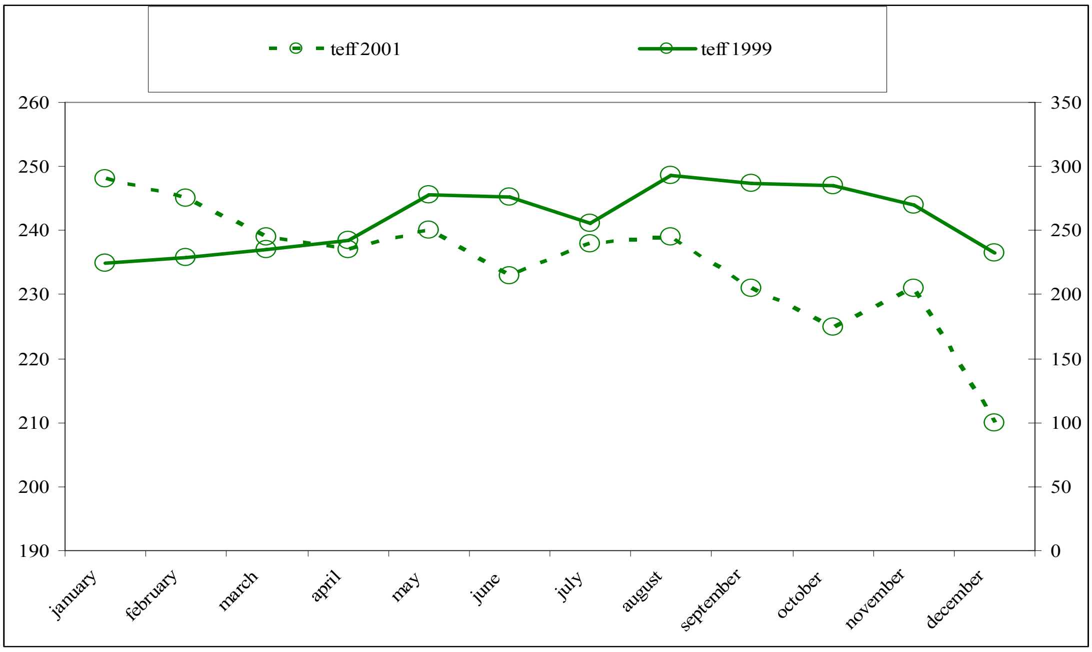

Figure 5a. Monthly average wholesale prices for teff (birr/100 kgs.), 1999 and 2001)

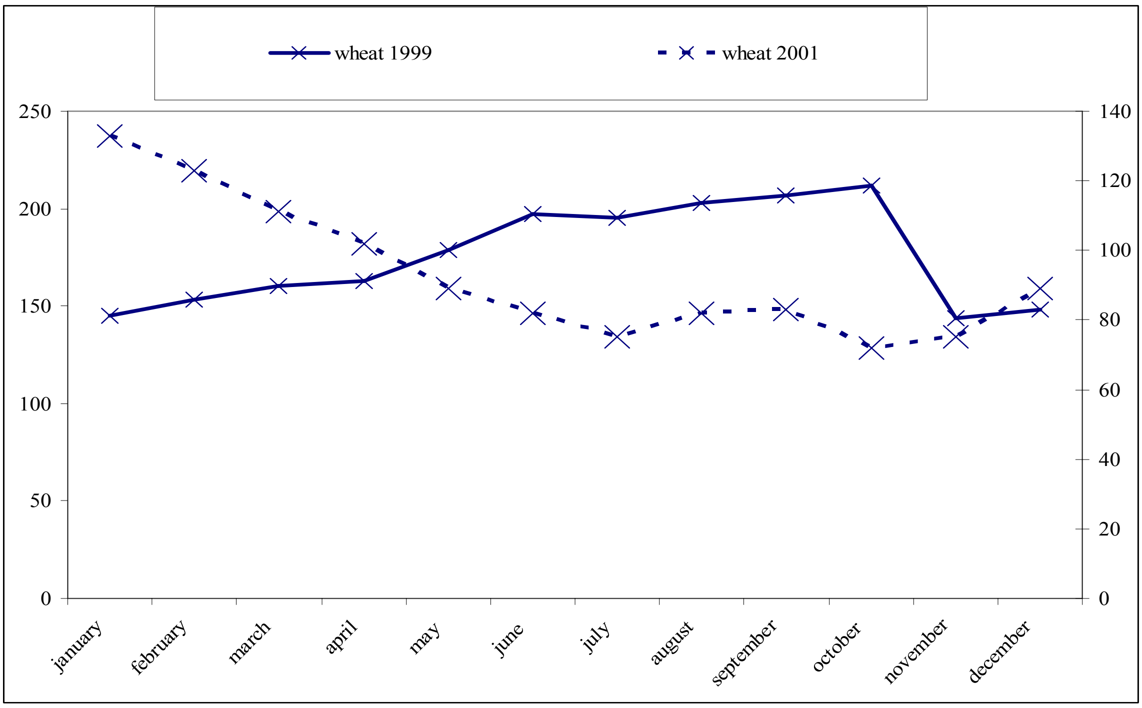

Figure 5b. Monthly average wholesale prices for wheat (birr/100 kgs., 1999 and 2001)

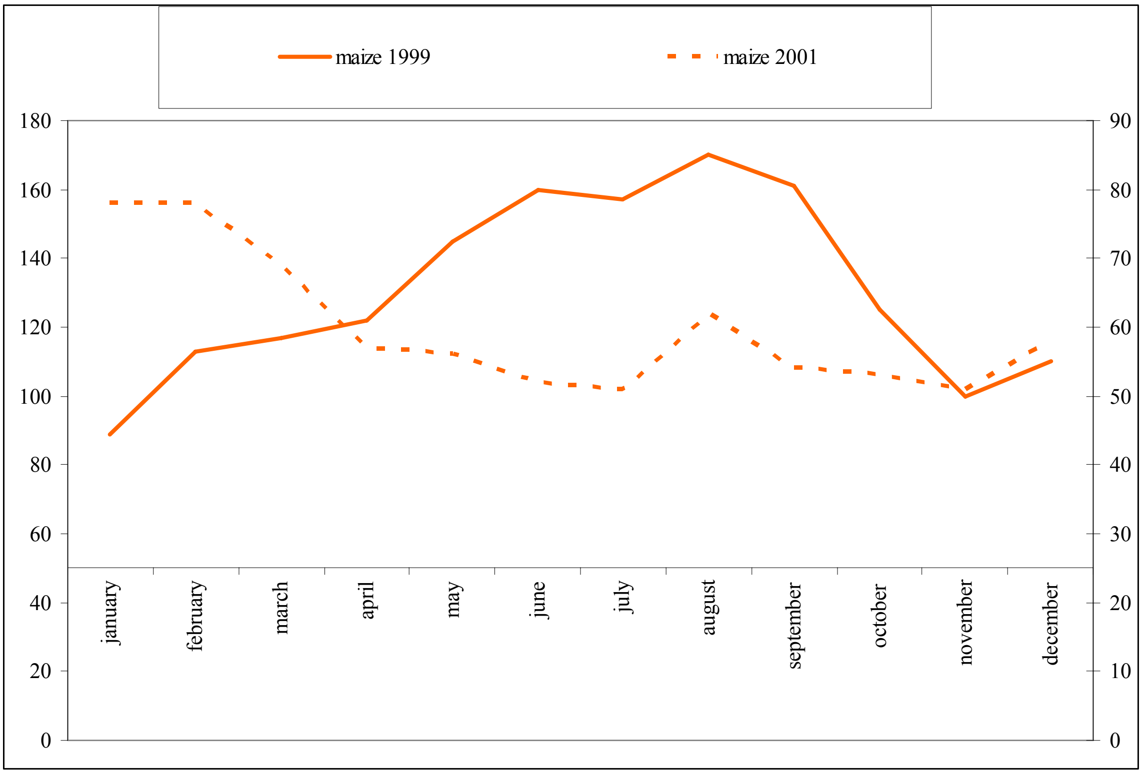

Figure 5c. Monthly average wholesale prices for maize (birr/100kgs., 1999 and 2001)

Source: Central Statistical Authority, various issues.

When grain prices are substantially reduced, it discourages farmers from applying chemicals to prevent pest attacks, leading to even larger crop losses than usual. This is because the marginal benefit as a result of chemical treatment could be less than the marginal cost of the treatment. For example, during the 2001/02 crop season, maize prices were reduced by as much as 80 percent, as a result of a 40 percent increase in output. Under such circumstances, crop prices might be so unattractive that farmers would not even pay the transport charges to take their grain to the nearest market place for sale.

7.2. Regression Results

Table 13 presents the Tobit regression results. Note that nonbag storage capacities were not significant. Education also was not significant in explaining variations in the dependent variable. Similarly, farmers' expectations of grain loss were found to be not statistically significant.

Table 13: Regression results (Tobit estimates: the dependent variable is the proportion of sales during the first quarter to total sales during the year)

Variables	Coefficient	t-ratio
Constant	0.7694*	6.296
FSIZE	0.0135**	2.119
SEX	-0.1407***	-1.926
EDUC	0.0014	0.303
CHEM	-0.0762**	-2.440
STCAP	-0.0011	-0.183
TLU	-0.0084**	-2.547
PRICDIF	-0.3026**	-2.429
EXPLOSS	0.0984	1.081
TAXLOAN	0.0001*	3.150
Sigma	0.2598	
Number of samples	292	
Log likelihood function	-30.9562	

*, **, *** Significant at 1 percent, 5 percent and 10 percent levels, respectively.

A total of six variables turned out to be significant in explaining the variations in the proportion of crop sales during the first quarter to total sales by households. Moreover, with the exception of the SEX variable, the signs of all of these variables are also according to a priori expectations, leading to the following conclusions:

(i) The pressure on households, triggered by large family sizes, to meet nongrain purchased consumption needs tends to force farmers into immediate crop sales;

(ii) Female household heads are more likely to sell crops immediately during the first quarter than male household heads. This may be ascribed to fewer options available to female-headed households in terms of resorting to other sources of cash income (for example, livestock sales);

(iii) Application of chemicals (insecticides) reduces the risk of pest attack and the tendency to instant sales;

(iv) Livestock ownership reduces the pressure to meet cash needs by selling crops, because households tend to resort to sale of livestock and its products rather than crop sales;

(v) Intercrop differences are important explanatory variables for households' behavior in sales decisions; that is, farmers who mainly grow maize (a more susceptible crop) and wheat are more likely to sell quickly than those who mainly grow teff (a less susceptible crop); and

(vi) Households' need for immediate cash to meet various obligations explains why they are willing to dispose of their grain crops when prices are lowest.

8. Conclusions

8.1. Summary of major points

Ethiopia is a structurally food-deficit country that depends heavily on food aid. Production of adequate food crops to achieve food security at national and household levels is a strategic food policy objective of the country. Post-harvest crop loss is a problem that adds to the difficulty of meeting these objectives by reducing the quantity, quality, and hence value of the crops produced. In a sense, it is a waste of effort and resources. Farmers, not wanting to take the risk of losing large amounts of their output, tend to sell a large proportion of their marketable surplus during the season immediately following harvest, when prices are actually depressed. Despite their strategic significance, not much attention has been paid to post-harvest grain management practices. Studies are not generally available.

Efficient and effective grain management practices minimize post-harvest losses at household, community, and national levels. Apart from reducing crop loss, good management practices generate employment opportunities, add significant value to products, maintain quality, enhance competitiveness in the market place (at both the local and national levels), and help maintain market stability, to mention just a few.

The purpose of this study was to identify the post-harvest grain management techniques that are actually practiced by farmers and to determine the extent to which farmers' perception of risk (market and post-harvest grain loss) influences their grain marketing patterns. Three areas, each known for production of one of the three major grain crops in Ethiopia were selected for the study: Ada for teff, Bako for maize, and Hetosa for wheat. A survey of 300 sample farm households was conducted to collect the relevant data. Both descriptive and econometric (Tobit regression) analyses of the data were conducted.

Clearly crop losses are not limited to the post-harvest period. In fact, substantial grain losses also occur before and during mowing and threshing of crops. It should also be noted that the magnitude of post-harvest loss should go beyond the deterioration in quantity and quality of grain crops to include costs associated with of the inputs used to produce the lost grains. However, the scope of the present study is limited to what happens after harvest. The findings of the study are summarized below.

Storage capacities are found to be quite limited: fixed structures are available to store only about 58 percent of the average volume of total output. About 80 percent of households reported that they did not have adequate fixed storage structures; they use temporary packing materials such as sacks for storage. So one of the reasons for immediate sales after harvest is the lack of adequate storage. Two-thirds of the households said they resort to such sales when production exceeds their storage capacity.

There is a widespread perception among farmers that post-harvest grain loss is an impending risk. Expected post-harvest grain losses per household varied substantially from a minimum of 150 kilograms to more than 2,000 kilograms, depending on crop type and season. Actual post-harvest grain losses per household reported during the 12 months preceding the study period varied from about 240 kilograms in the Ada area (where teff is the dominant crop) to about 700 kilograms in the Bako area (where maize prevails). On average, about 12 percent of grain production was reportedly lost after harvest while in storage. Assuming that this accurately portrays the proportion lost at the national level, prevention of this amount of loss could substantially reduce the food deficit.

Some crops such as maize cannot be stored longer than three months before they are attacked by storage pests (notably, weevils). Since processing is not common, treatment with chemicals and other indigenous techniques are practiced to reduce these grain losses. Aeration and treatment with chili peppers are the most common indigenous techniques used by farmers. Other stock management techniques exist but they are less important.

The proportion of marketed surplus to total grain output for Hetosa, Ada, and Bako was found to be 40 percent, 63 percent, and 48 percent, respectively. A considerably higher proportion of total production of the major crops, wheat, teff and maize, was marketed compared with other crops grown in Hetosa, Ada, and Bako. On aggregate levels, the proportion of actually marketed output during the first quarter of 2002 was about 51 percent of total marketable surplus for the entire year[32]. The average percentage of crops sold declines as one moves from the first quarter through the fourth quarter, while grain prices tend to rise as one moves from the first quarter through to the third and, in some cases, even during the fourth quarter.

Tobit regression was used to identify the factors that explain why farmers would resort to instant sales at lower prices. The proportion of actual sales during the first quarter (following harvest) was regressed on a number of explanatory variables including family size, sex of the household head, education level achieved, chemical usage to reduce pest attack, storage capacity, livestock ownership, expectation of loss, interseasonal price variations, and financial dues owed to the government including taxes and repayment of input loans.

Results indicate that sales of crops immediately after harvest are triggered by (1) a temporary need for cash to pay off debts or make purchases and (2) by concerns about impending post-harvest grain loss and the limited capacity to prevent it. Hence, the variables family size, female head of household, and tax and loan repayment schedules that coincide with the harvest were found to be significant and positively associated with early crop sales. However, livestock ownership and the capacity to apply chemicals (insecticides), both indicators of wealth, were also found to be significant but negatively associated with early crop sales. Cropping patterns suggest that those who cultivate crops that are more susceptible to pest attacks (such as maize) are more likely to dispose of their crops immediately after harvest at lower prices than those who cultivate less susceptible ones (such as teff).

8.2. Policy Implications

In Ethiopia, policy has focused on production and marketing of foodgrains, while post-harvest grain management practices have been almost completely neglected at both macro and micro levels. Therefore, very little capacity exists for efficient and effective post-harvest grain management systems at national, regional, community, or household levels. As a result, grain markets are characterized by high interseasonal and intertemporal volume and price

[32] The figures for marketable surplus of grains are significantly higher than the national average reported elsewhere (26 percent), whereas the percentage of actually marketed grain crops during the first quarter immediately after harvest is lower than the national average reported elsewhere (79 percent). This reflects the upward bias in the selection of regions and sample households, which was on purpose.

fluctuations. Although the incidence of food insecurity is high, Ethiopia has lost an important opportunity to reduce post-harvest losses.

Hence, it is important for policymakers to consider post-harvest grain management a strategic policy concern. They must become more aware of the problem. In particular, they must view post-harvest grain management practices not only from the perspective of lost food security, but also as an economic activity with employment, value, and income linkages.

Liquidity constraints and impending risk of post-harvest grain losses were the two most important factors explaining farmers' tendencies to sell their grain crops instantly. The selling and repurchasing of grains as a post-harvest management practice was found to be less significant. As it stands now, neither grain credit or output markets can be relied upon, and market risks are substantial. Lending grains to others was also found to be less important as a stock management strategy in the context of an imminent risk of post-harvest loss, perhaps because the demand for grain on credit is lower during the period immediately after harvest. One would expect that the demand for borrowed grain would come from rural households whose grain production was inadequate or those with insufficient cash to buy grain at the market. Demand for grain credit is the least during the first quarter and the highest during the third quarter after harvest—a pattern that strictly follows grain price levels.

Policies to relax liquidity constraints might include efforts to improve access to credit and rescheduling due dates for payments to the government so that they fall due later in the year, when crop prices are better. In other words, mechanisms linking credit markets to grain markets should be sought, enabling farmers, for example, to take cash loans in the post-harvest season to cover their various obligations. Repayment could be scheduled for later seasons when prices pick up. Diversification of cash sources and integration of the production process with markets would allow farmers to make decisions that are more market oriented rather than subsistence driven. Policies to support disadvantaged sectors such as female-headed households and the poor are also important, since they are more susceptible to shocks.

But these policies must be complemented by interventions to enhance the capacity of farmers to prevent post-harvest losses, at household, community, and national levels. Otherwise, farmers may dispose of their grains any way they can and as soon as they can to avoid storage losses, in which case they may be unable to repay their loans, making the matter even worse. Because chemical treatment has proved so effective, it is important to link input markets to future product markets. Interventions also need to take into account and build on farmers' resources and knowledge including indigenous techniques.

The problem is that quite often markets do not perform well. Hence, there is clearly a need for introducing and strengthening appropriate institutions to enable markets to work better. One viable option would be to introduce a grain warehouse receipt system, so that farmers would deposit their marketable surplus to be sold when prices are higher. There are legitimate reasons to suspect that increased production and availability could lead to an increase in household consumption, instead of in marketed surplus. We know that farmers produce grain primarily for their own consumption, not for sale. One reason why the warehouse receipt system of grain management and forward grain markets make a lot of sense, in addition to preventing post-harvest loss, is that they promote monetization of production and facilitate processing. As the experiences of other countries have shown, there are also a number of other advantages including easing access to financing at all levels in the marketing chain, moderating seasonal price variability, maintaining quality standards, and promoting instruments to mitigate price risks. They also help reduce the need for government intervention in grain markets as well as the costs of such interventions[33] (see Coulter and Onumah 2002). Above all, the introduction of well-managed warehouses into rural villages would reduce post-harvest grain losses, ultimately supporting the country's effort to ensure national food security.

Although not reported as a variable in this study, the need to encourage attitudinal changes, regarding consumption versus saving and accumulation cannot be overemphasized. Expenditure and consumption of grain are quite high during the season immediately following harvest, compared with the farmers' standard of living the rest of the year. Farm households often sacrifice much of the grain they produce to pay for weddings and other social ceremonies. A shift of emphasis to saving could improve farmers' lives and the economic stability of the country as a whole. Finally, more in-depth studies are needed to inform policy on credit and saving options (including options for introducing grain warehouse receipt systems), traditional methods of grain treatment (including research on their effectiveness, economy, and health effects), and farm and nonfarm linkages and the scope for the development of agro-processing industries, including small-scale, farmer-managed grain processing technologies.

[33] In a warehouse receipt system (WRS), farmers store their marketable surplus (/or any part of their produce not required for immediate consumption) in a modern warehouse located in their village. To certify their deposit, they receive a receipt from warehouse managers that indicates the type and amount of produce they stored. A WRS facilitates the development of an efficient and accessible rural financial system and helps introduce an inventory credit system. farmers can obtain formal credit by pledging their grain deposits. This allows peasants to progress from being "pricetakers" to being "price negotiators" and to operate successfully in the local market economy. At present, due to high seasonal grain price fluctuation, inventory credit may be profitable because interseasonal price differences can adequately cover storage costs. Nevertheless, in the long run, as agricultural markets become more efficient, grain price fluctuations will be reduced, thereby making inventory credit infeasible. In the long –run, peasants will become commercial farmers who may adopt a different way of running farm businesses. Therefore, it is important to note that the introduction of an inventory credit is a means to an end rather than an end in itself. The introduction of improved farmer-managed warehouses in rural areas may also improve agricultural marketing; it may help farmers to hold commodities for later sale when prices are higher. It will also enable peasants to supply raw materials year-round to small-scale food processors uniformly, which paves a way for the development of rural small-scale industries. Furthermore, the WRS will facilitate an efficient and effective grain marketing system, since marketing functions such as grading and standardization will be more applicable in rural areas. (Coulter and Onumah 2002). However, sufficient care needs to be exercised if grain warehouse systems are to achieve intended results. For example, Berg and Kent (1991) state that cereal banks were bound to fail because of basic misconceptions in their design and implementation. Gunther and Muck (1995) say that some conditions must be imposed if cereal banks are to operate successfully. They should (a) consider and help meet the needs of the users;(b) provide social cohesion in the target village; (c) provide human, financial, and technical resources with management support; and (d) be profitable.

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Appendix: Supplementary Tables

Appendix Table 2. TLU conversion factors

Type of Livestock	Conversion Factor
Ox	1.00
Cow	1.00
Heifer	.75
Young bull	.80
Calf	.20
Sheep	.13
Goat	.13
Horse	1.10
Donkey	.70
Mule	1.00

Source: Abebe 2000.

Appendix Table 1. Descriptive statistics of the explanatory variables

Variable	Mean (Percentage with value 1 in case of dummy variable)	SD
SEX	94.50	-
FSIZE	8.00	2.6394
EDUC	7.58	3.6309
CHEM	56.60	-
STCAP	2.55	2.9747
TLU	8.44	5.4844
EXPLOSS	0.12	0.1827
PRICDIF	0.63	0.1419
TAXLOAN	654.40	753.5430

Part three – Private Provision of Public Goods

CHAPTER EIGHT

Collective Action in Canal Irrigation Systems Management in Uganda

D. Sserunkuuma, N. Ochom and H. Ainembabazi

Collective Action in Canal Irrigation Systems Management

I. Introduction

Uganda's agriculture is largely rain-fed. But rainfall is becoming increasingly unreliable, reducing crop yields and increasing food insecurity (Pender et al., 2001). Therefore, irrigation is considered one option for enhancing agricultural production. Whereas in the past many sub-Saharan Africa governments provided subsidized agricultural inputs and services in controlled-market environments, today there is a policy shift towards devolution of such services, including the management of natural resources from governments to user groups on the premise that local farmers will have comparative advantage over the government in monitoring and managing such resources through collective action (Meinzen-Dick, et al., 2000).

There are many examples of successes and failures of collective action due to either the absence or breakdown of institutions needed for successful collective action (Baland and Platteau, 1996; Bromley, 1992; Ostrom, 1990; Ostrom, 1992; Runge, 1981; Sarris and Tinios, 1994; Sarris and van den Brink, 1993). When governments fail to effectively manage natural resources, it is not given that resource-users will automatically take over and successfully management the resources, especially if such transfer of responsibility is accompanied by more demand on their time and money (Meinzen-Dick, et al., 2000). There is, therefore, a need to examine the willingness of resource-users' to participate in such collective action because it is critical for the effective implementation of the devolution policy and the development of supporting policies to sustain the collective action in user-managed natural resource systems.

The objective of this study is to determine the extent of farmers' participation in the collective action of maintaining the Doho Rice Irrigation Scheme (DRS) canals after the transfer of the responsibility from the government, and to identify factors influencing farmers' participation and compliance with a user-fee payment bylaw. The study was conducted at the DRS in Tororo District, Uganda through a survey of 411 households that produced rice in the first or second crop seasons in 2001. The study is organized as follows: section 2 presents the history of rice production and management of the DRS irrigation system. Section 3 discusses the research questions and methodology used while section 4 presents the research findings. Section 5 concludes the report and highlights some policy implications.

II. History of Rice Production and Management of DRS

Rice production in Doho swamp started in 1942 to feed World War II soldiers. After the war, production declined until 1972 when the government committed to revitalize rice production. However, several factors constrained this effort including flooding of River Manafwa, scarcity of irrigation water during the dry season, pests and diseases, and lack of high-yielding varieties (Ogwang, not dated). In 1974, the farmers appealed for government intervention and the latter bought the Doho Swamps and constructed a rice irrigation scheme with help from Chinese experts between 1976-1985.

The objectives of DRS were to popularize rice production, provide irrigation water and supply farmers with improved seeds, farm tools, and marketing and milling services. The government demarcated the land and allocated plots to individual farmers. After Phase II of the project was completed in 1989, the Chinese experts transferred the DRS management to the Ugandan government.

The DRS has a total area of 2,500 acres, out of which 2,380 acres are cultivable and are partitioned into six blocks. A chairman, who also has the responsibility of cleaning irrigation canals, maintaining roads and collecting irrigation user-fees from farmers manages each block. Strip leaders in-charge of 20-acre land-strip assist the chairman while an executive committee, elected by the farmers, and technical staff runs the whole scheme.
The irrigation water used by farmers at DRS comes from River Manafwa, which originates from Mt. Elgon. Its main stream is 70 km long and covers a catchment area of 570 km^2, where much agricultural activities take place and deposit silt into the river and irrigation canal, reducing the amount of water supplied and rice yields as irrigation canals get silted.
In the past, the canals were regularly de-silted by the Uganda government. But starting in the late 1980s, the government withdrew its direct provision of agricultural inputs and services and maintained only payment of staff salaries. As a result, the government's contribution to DRS reduced drastically and the silting of irrigation canals worsened.

In January 1994, heightened concern about reduced efficiency of the irrigation system (manifested in reduced water conveyance) prompted the DRS management to call a high level meeting, which included local and district authorities, to identify means of resolving the problem. A decision was made for farmers to pay an irrigation user-fee of Ushs. 5,000 per acre per season, and a committee was set up to collect the funds and execute the de-silting. The de-silting exercise started in May 1994 using hired labour but was halted in November 1994 due to shortage of funds due to misappropriation and non-compliance of some farmers with the user-fee payment. In December 1994, the DRS farmers formed an association, the Doho Rice Scheme Farmers' Association, to which the government is in the process of devolving responsibility of managing the scheme.

III. Objectives, Data and Methodology

Objectives

This study addresses three main questions. First, what are the existing incentives (benefits) for participation in collective action or payment of irrigation user-fees at DRS and what extent does this motivate collective action? Second, how effective is enforcement of existing bylaw on user-fee payment? Lastly, why do some farmers comply with the bylaw and others do not?

Data

The study used data from 411 households selected using a stratified random sampling technique from among DRS rice-producers in 2001. Participation in collective action is measured by degree of compliance with the bylaw requiring all DRS farmers to pay the irrigation user-fee. Surveyed households were then grouped into three groups based on level of compliance (none, partial and full-compliance).

Fourteen households (<4%) did not comply with the by-law and never paid any user-fees for either the first or second crop season in 2001. 128 households (30%) partially complied, that is, paid the user-fees for one of the two crop seasons in 2001 for at least one of the plots. 269 households complied fully, paying user-fees for all their plots in both seasons in 2001.

Methodology

Descriptive statistics were used to address the first two study questions on incentives and enforcement of participation in the DRS collective action. An Ordered Logit Model (OLM) Regression was used to address the third study question, with an ordinal measure of compliance being constructed from three levels of compliance (none, partial and full) and this was used as the dependent variable (Long, 1997). The OLM is specified as:

$$y^* = X'\beta + \varepsilon$$

$$y = 1 \text{ if } y^* < b_1$$
$$y = 2 \text{ if } b_1 \leq y^* < b_2$$
$$y = 3 \text{ if } y^* \geq b_2$$

where:

y^* is the unobserved continuous variable measuring the net benefit of complying, which predicts the observed degree of compliance $y = 1,2,3$
X is a vector of explanatory variables
ε is the unobserved error term that is assumed to be normally distributed
b_1 and b_2 are parameters and β is the "true" vector of parameters estimated in the regression analysis.

VI. Variable Selection and Hypotheses

Perceived direct economic benefits from de-silting and increases in irrigation water supply motivate irrigation fee-payment as a collective action. The amount of irrigation water available is directly proportion to the distance of field plot from irrigation canals, with an inverted U-shaped relationship between water scarcity and participation in collective action (Meinzen-Dick et al., 2000; Bardhan, 1993). As a result, farmers receiving plenty of water tend not to be active participants and the same applies to those expecting too little water.

Land ownership or tenure security promotes conservation of natural resources such as land and water (Pender et al., 2001). Most farmers at DRS own their land but others lease, borrow or sharecrop their land. The latter regard payment of rental and irrigation fees as incentives to retain access to the land. In other words, compliance guarantees access to land. But weak bylaws and poor enforcement may compromise that relationship such that the effect of land ownership on participation becomes ambiguous.

Wealth or asset endowment might reduce the incentive to participate in collective action (White and Runge, 1992). This is especially true when wealth provides alternative investment choices. Also, some wealthy farmers lease-out or sharecrop their land, making them unlikely to participate in the collective action (White and Runge, 1992). But wealth may also enhance participation in collective action through greater access to technology, land or other services. Wealth also facilitates fee-payment where cash-contributions are made, increasing participation. Thus, the wealth status of a household has an ambiguous effect on participation in collective action.[1]

Age of household head, as proxy to experience in rice production, is ambiguous because older farmers are expected to have better understanding of the consequences of non-compliance with irrigation fees payment. But this experience may make them more or less willing to comply, depending on whether the experience has been good or bad. Also, since older and more experienced farmers grew rice when the government bore the cost of de-silting canals, they are likely to be more resistant to the new fee arrangement and fail to comply.[2]

Education directly influences adoption of improved technologies. Combined with *influence and external recognition*, education enhances successful organization towards collective action (Meinzen-Dick et al., 2000). However, because it also increases people's opportunities outside agriculture, education may lower participation in collective action (Nkonya et al., 2001). On the other hand, educated farmers may have other non-agricultural income sources that make it easier for them to pay the irrigation user-fees, enhancing their participation in the collective action, as do households with *alternative major income sources* rather than rice-production.

Agricultural training and extension on soil and water conservation increases farmers' awareness of siltation problems and appreciation of the need to pay the user-fees to overcome the problem. A *high dependency ratio* translates into a higher subsistence burden and less money to pay user-fees. *Female-headed households* tend to have limited access to services and resources, and are less likely to pay the user-fees, although they may be hard-pressed to participate as custodians of food security. A high *share of a household's food and income from rice* will likely enhance participation in collective action aimed at increasing irrigation water supply and rice output. *Access to credit* and *farmers' savings* will enhance the ability to pay user fees.

IV. Results and Discussions

From Descriptive Statistics

Table 1 shows that nearly all (99%) of all DRS farmers reported irrigation water as their greatest benefit from DRS, followed by extension and technical advice (50%). Rice milling (41%) and rice marketing (22%) were also considered potential benefits, though these are services offered directly by DRS. There was no significant difference between these proportions across the three categories of compliance.

Table 1: Benefits received by rice farmers from DRS and farmers' perception of these benefits relative to costs

[1] Six variables were used to proxy wealth: number of rice plots owned; total area of land owned; value of oxen owned; value of other livestock owned; owns a cemented-floor house; and owns metal-roofed house. Only number of rice plots owned and owns cemented-floor house were used in the regression analysis.

[2] Because age and experience in rice growing are highly correlated, only experience is used in the regression model.

Benefit/service	% Households reporting			
	All HHs N = 411	**Category 1 N = 14**	**Category II N = 128**	**Category III N = 269**
Irrigation water	98.5	100.0[a]	99.2[a]	98.14[a]
Rice milling	40.87	21.43[a]	41.41[a]	41.64[a]
Extension and technical advice	50.36	50.0[a]	54.69[a]	48.33[a]
Marketing/collection center	22.38	14.29[a]	21.88[a]	23.05[a]
Perception of benefits in relation to costs				
First season				
B<C	20.4	28.57[a]	17.97[a]	21.19[a]
B=C	11.9	7.14[a]	14.84[a]	10.78[a]
B>C	67.6	64.29[a]	67.19[a]	68.03[a]
Second season				
B<C	26.7	42.86[a]	30.47[a]	24.16[a]
B=C	13.3	7.14[a]	18.75[a]	11.15[a]
B>C	59.9	50.0[a]	50.78[a]	64.68[a]

N=Number of households reporting. Different superscripts mean statistically significant differences across categories

Table 1 also shows that most DRS farmers (68% in first season and 60% in second season) perceived that the benefits they derived from DRS outweighed the costs they incurred, which included payment of user-fees and additional labor supplied to de-silt the irrigation canals when funds were insufficient. The proportion of those perceiving the benefits were lower than the costs was 20% in the first season and 27% in the second season; and those perceiving the benefits to be equal to the cost constituted 12% and 13%, respectively. Between one-fifth to one-quarter of farmers perceived that the benefits derived from DRS were not worth the cost incurred. This perception was a disincentive to paying the user-fee, with one-third of the farmers failing to comply fully with the bylaw.

Most farmers felt benefits from DRS, save for marketing[3], had deteriorated in the past 10 years, with supply of irrigation water and provision of extension/technical advice being most affected (Table 2). They blamed the former on a frequent breakdown of the DRS excavator and resultant siltation of the canals and reduction of the amount of water supplied (Table 3). Inadequate water supply led to lower rice yields and inability of farmers to comply with the user-fee payment (Tables 4, 5, 6 and 7). Other reasons cited for non-payment included inadequate income and low or lack of rice harvests (Table 7).

3 The reason why farmers perceive marketing services to have improved could be attributed to the government policy of market liberalization.

Table 2. Perceived change in benefits/services derived from DRS in the past 10 years.

Benefit/service	**% HHs reporting improvement**	**% HHs reporting Deterioration.**
Irrigation water (N = 375)	1.9	98.1
Rice milling (N = 122)	41.8	58.2
Extension and technical advice (N = 156)	17.3	82.7
Marketing/collection center (N=37)	56.7	43.2

N=Number of households reporting.

Table 3. Reasons for deterioration in benefits derived from DRS

Benefit/reason for deterioration	**% HHs reporting**
Irrigation water (N = 350)	
Breakdown of excavator/increased siltation of irrigation canals	73.1
Change in rainfall pattern	17.4
Rice milling (N = 64)	
Depreciation and poor maintenance of the private milling machines.	95.3
Extension and technical advice (N = 110)	
Lack of facilitation/motivation of DRS administration.	28.18
Lack of commitment and coordination of DRS administration.	27.27
Reduced number of extension staff following government withdrawal from DRS and retrenchment in the civil service sector	41.8
Marketing/collection center (N = 11)	
Low prices of rice	54.5
Low quality of rice attributed to old milling machines.	36.4

N=Number of households reporting.

Table 4. Adequacy of irrigation water received by household in the first and second seasons of 2001

Adequacy of irrigation water received	**% Households reporting (N=411)**	
	First season	Second season
Received adequate water throughout the season	85.4	48.2
Received adequate water part of the season and inadequate water the other part	12.9	24.1
Received inadequate water throughout the season	7.5	31.4
Received inadequate water part of the season and no water at all for the other part	1.9	8.3
Received no water at all throughout the season	1.2	5.6

N=Number of households reporting. The figures add up to more than 100% because some respondents had more than one plot of land.

Table 5. Correlation between adequacy of irrigation water received on rice plot and yield

Adequacy of irrigation water received	**Correlation with rice yield**	
	First season (N=614)#	Second season (N=589)#
Received adequate water throughout the season	0.098**	0.091**
Received adequate water part of the season and inadequate water the other part	-0.036	0.005
Received inadequate water throughout the season	-0.046	-0.039
Received inadequate water part of the season and no water at all for the other part	-	-0.022

#N=Total number of plots used in the analysis **=Correlation is significant at 5% level of significance

Table 6. Rice yields and payment of irrigation fees

Season	**Average Yield (Kgs/Acre)**			
	All Plots	**Category 1**	**Category II**	**Category III**
First season	1474.6	1394.3^{ab}	1387.9^{a}	1516.2^{b}
	(31.25)	(148.9)	(62.4)	(36.5)
	N=614	N=15	N=185	N=414
Second season	1570.8	1562.7^{ab}	1445.9^{a}	1634.9^{b}
	(32.78)	(86.1)	(57.3)	(42.6)
	N=589	N=34	N=187	N=368

N=Total number of plots used in the analysis. Numbers in parentheses are standard errors
Different superscripts mean statistically significant differences across categories.

Table 7. Reasons Given by farmers for not paying irrigation fees

Reason	**% Households reporting**	
	First season	Second season
Received inadequate or no water at all.	13.3	16.7
Service for which fee was collected was not provided in previous season.	11.1	5.6
Did not have enough money	22.2	15.1
Irrigation fee was not collected from the farmers	15.6	15.1
Belief that had to pay in only one season	13.3	17.5
Had poor or no rice harvest at all	2.2	7.1
Had not yet harvested (pays after harvesting)	2.2	8.7

* In this particular case N exceeds the actual number of farmers/households that didn't pay irrigation fees because some respondents gave more than one reason for not paying irrigation fee.

There is a bylaw against non-payment of irrigation fees and defaulters lose their plots in the following season. 45 percent of the farmers ranked the fee collection procedure as unsatisfactory (Table 8). Flaws in the collection methods could be a reason why some farmers failed to pay their fees. But it was also evident that only about one-quarter of the farmers understood the correct interpretation and penalty of the fee-payment bylaw, a fact that could influence compliance (Table 9). There is a need therefore, for more education to make sure everybody understands the bylaw.

Table 8. Farmers' perception/ranking of the irrigation fee collection procedure

Ranking	% Households reporting	
	First season	Second season
Very well	1.6	1.0
Well	53.9	50.9
Fairly well	27.6	31.1
Poor	15.3	14.9
Very poor	1.6	2.1

Nkonya et al. (2001) observed that it is difficult to effectively enforce bylaws and restrictions that are not clear to farmers. Besides, poor and selective enforcement of the bylaw, evident in Table 10, perpetuates non-compliance. Three-quarters of the farmers rated the current DRS administration poor to fair, mainly as a result of poor maintenance of irrigation facilities and corruption (Table 11 and Table 12). These administrative weaknesses result in inadequate fee collection, irrigation canals not being de-silted well, less water supply, poor rice harvests and a vicious cycle between reduced irrigation water and non-payment of fees. Without a guarantee of adequate irrigation water supply, it may be difficult to enforce the fee payment. Hence, there is need to rehabilitate the entire irrigation system and institute proper management procedures before handing it to the farmers.

Table 9. Farmers' knowledge/awareness of penalty for non-payment of the irrigation fees

Perception	% Households (N=360)
Plot withdrawn from defaulter for two seasons	56.7
Plot withdrawn from defaulter for one season	25.0
Plot withdrawn for unspecified period	13.1
Defaulter is fined Ushs 2000	1.7
Defaulter fined Ushs 1000	0.8
No penalty	0.3
Defaulter is given warning	0.8
Plot withdrawn for three seasons	0.6
Plot withdrawn for ever	0.6
Plot withdrawn till farmer complies	0.6

Table 10. Categories of defaulters that usually go unpunished

Defaulter category	% Households reporting (N = 112)
Relatives of enforcers	28.6
Friends of enforcers	33.0

Enforcers themselves (DRS administration)	26.8
Rich/influential individuals	7.1

Table 11. Farmers' perception/rating of performance of current DRS administration

Rating	**% Households reporting (N = 411)**
Very good	0.5
Good	25.5
Fair	17.3
Poor	48.2
Very poor	8.5

Table 12. Reasons for poor to very poor job rating of DRS Administration

Reason	**% Households reporting**	
	Poor (N=198)	Very poor (N=35)
Poor inspection and maintenance of irrigation canals to ensure adequate water supply.	42.4	20
Lack of commitment/Giving priority to private issues and neglecting administrative ones	5.6	5.7
Not paying attention to farmers' problems.	9.6	17.1
Poor accountability/high level of corruption/ lack of transparency	29.8	31.4

N=Number of households reporting.

Table 13. Methods of land acquisition

Method	**% Households reporting**			
	Entire Sample (N=411)	**Category 1 (N=14)**	**Category II (N=128)**	**Category III (N=269)**
Purchase	34.1	35.71[a]	32.81[a]	34.57[a]
Gift/inheritance	40.4	28.57[a]	43.75[a]	39.41[a]
Government/DRS administration	38.4	50.0[a]	35.16[a]	39.41[a]
Rented in	7.1	0.0[a]	6.25[a]	7.81[a]
Borrowed	0.7	-	-	-
Share-cropped in	0.2	-	-	-

(-) Test for differences in proportions not conducted because of very few observations.
Different superscripts mean statistically significant differences across categories
Note: The column % add up to more than 100% because there are households with more than one plot, each plot acquired through different means.

Table 14. Measures of wealth status of a household

Asset category	Entire sample	Category 1	Category II	Category III
Average number of plots of land owned in DRS	1.6 (0.042) (N=411)	1.93[a](0.322) (N=14)	1.60[a](0.076) (N=128)	1.58[a](0.05) (N=269)
Average total area (acres) of land owned at DRS	1.27 (0.054) (N=411)	1.74[a] (0.433) (N=14)	1.28[ab] (0.096) (N=128)	1.25[b] (0.065) (N=269)
Average value (Ushs) of oxen owned	571,750 (53,698) (N=40)	725,000[a] (575,000) (N=2)	634,546[a] (106,621) (N=11)	534,815[a] (59,118) (N=27)
Average value (Ushs) of other livestock assets owned	427,296 (34,875) (N=366)	412,250[a] (195,040) (N=12)	480,982[a] (82,612) (N=119)	400,879[a] (33,337) (N=235)
% HHs with main residential house having a metal roof	63.3 (N=406)	71.4[a] (N=14)	59.8[a] (N=127)	64.5[a] (N=265)
% HHs with main residential house having a cemented floor.	16.0 (N=406)	28.6[a] (N=14)	14.2[a] (N=127)	16.2[a] (N=265)

*Different superscripts mean statistically significant differences across categories

There is no means to blocking water supply to individual defaulters, making it hard to enforce the fee-payment bylaw. Elsewhere, successful collective action was strengthened by effective enforcement that enabled administrators to cut-off water supply or impose a penalty to non-complying farmers. For instance, Meinzen-Dick et al. (2000) found that farmers in India absenting themselves from communal activities had to pay a penalty of 30-60 rupees per day per person. If a farmer refused to pay, the users' group stopped water supply to their plots and doubled the penalty, increasing compliance. In DRS, there are no such mechanisms. Most DRS farmers own their land so that threatening to withdraw their plots is not effective, except to those who rent or borrow land (Table 13). Therefore, tenure security acts as a disincentive to enforcement and compliance. There is need for alternative, innovative compliance-enhancing mechanisms.

The wealth status of a household was measured using six variables: number of plots, total land area, value of oxen, value of other livestock, having cemented-floor house and having a metal-roofed house (Table 14). Among all these variables, only total land area significantly differs between non-complying, partially complying and full-complying farmers. Table 15 shows that education of household head, dependency ratio and share of household income from rice vary significantly between the different household categories.

Table 15. Other socio-economic variables influencing participation in collective action

Variables	Entire sample (N=411)	Category 1 (N=14)	Category II (N=128)	Category III (N=269)
Average age of HHs head	45.99 (0.690)	51.29[a] (4.241)	45.81[a] (1.172)	45.80[a] (0.868)
Experience (years) of growing rice at DRS	18.69 (0.428)	18.79[a] (1.902)	19.50[a] (0.794)	18.30[a] (0.525)
Education (years) of HH head	5.79 (0.190)	7.14[ab] (1.13)	6.41[a] (0.312)	5.42[b] (0.240)
% Male headed households	94.2	92.9[a]	95.3[a]	93.7[a]
Dependency ratio	2.18 (0.062)	2.38[ab] (0.230)	1.98[a] (0.105)	2.27[b] (0.080)
% HHs received agricultural training on soil and water conservation	3.6	0.0[a]	4.69[a]	3.35[a]
% HHs that received extension visits in 2001 on the subject of irrigation water management.	3.4	0.0[a]	3.91[a]	3.35[a]
Average Number of extension visits received in 2001 on the subject of irrigation water management.	2.71 (438) (N=14)	-	2.80[a] (0.860) (N=5)	2.67[a] (0.527) (N=9)
% HHs participating in programs and organizations whose main activity is agricultural training.	4.14	0.0[a]	3.91[a]	4.46[a]
% HHs with salary/wage employment as the most important income source	5.84	14.29[a]	5.47[a]	5.58[a]
% HHs with sale of crops other than rice as the most important income source.	3.16	0.0[a]	1.56[a]	4.09[a]
% HHs with sale of rice as the most important income source	81.8	78.57[a]	83.59[a]	81.04[a]
% HH income contributed by rice	62.13 (0.012)	55.9[ab] (0.083)	59.1[a] (0.020)	63.9[b] (0.015)
% HHs food consumption contributed by rice	22.53 (0.008)	18.79[a] (0.056)	23.71[a] (0.013)	22.16[a] (0.010)
% HHs applied for credit from formal sources in 2001	14.1	7.14[a]	13.28[a]	14.87[a]
% HHs applied for credit from informal sources in 2001.	46.0	71.43[a]	42.19[b]	46.47[b]
% HHs saved by keeping money in bank or at home in 2001.	46.0	42.86[a]	46.88[a]	45.72[a]
% HHs saved by buying capital assets or re-invested surplus money immediately in income generating activity.	43.8	50.0[a]	42.97[a]	43.87[a]

Different superscripts mean statistically significant differences across categories.
(-) Test for differences in proportions not conducted because of very few observations.
Numbers in parentheses are standard errors; N=Number of households reporting.

Results from Regression Analysis

Table 16 presents the description of variables used in the regression analysis. Because income share of rice is endogenous, its inclusion in the model explaining participation in collective action would likely produce biased estimates because of its high correlation with the error term. To solve this problem, a two-step approach is used: the first step estimates an Ordinary Least Squares (OLS) regression model of determinants of the household income share of rice (Table 17). The results of this regression indicate that number of plots owned (wealth) and compliance are significantly and positively related to the household share of income from rice. The results also show that education, gender, value of livestock, savings, access to credit, crop income (rather than from rice) and wage income are negatively related to the household share of income from rice.

Predicted values from the OLS regression in Table 17 are then used together with other exogenous variables as regressors in the Ordered Logit Model (OLM) explaining participation in collective action (Table 18). The regression results show significant positive relationships between participation in collective action and the predicted values of household income share of rice, male-headed households, household dependency ratio, training on soil and water conservation, cemented-floor house, crop income (rather than rice) and access to credit. There are significant negative relationships between participation in collective action and number of rice plots, tenure security, experience in rice farming and perception that costs of participation exceed the benefits.

IV. Conclusions and Policy Implications

Regulation and incentives are some of the strategies used by policy makers to address natural resource management problems, particularly those requiring collective action (Abler and Shortle, 1991). Direct economic benefits are the prime motivation for participation in collective action (White and Runge, 1992). Thus, participation in collective maintenance of the DRS could be enhanced by improvement in the delivery of services or benefits that farmers derive from the scheme. These benefits include irrigation water supply, rice milling services, extension and technical advice and using DRS as a marketing/collection center for rice.

Since several private entrepreneurs constructed milling plants at, and around, DRS, farmers now benefit from better access to these private milling services than their counterparts outside DRS. Also, because of a large population of rice farmers who collectively produce and mill rice at DRS, many rice traders converge there to buy rice, making DRS serve as a rice marketing or collection center. DRS farmers can produce two or more crops compared to their Non-DRS counterparts because of the irrigation water. Additionally, DRS's technical staff provides extension and technical services on rice growing, irrigation water management and soil and water conservation, improving the knowledge and management of DRS farmers.

Table 16. Description of explanatory variables used in the regression models

VARIABLE	DESCRIPTION
% RICEINC	Proportion of household cash income contributed by rice in 2001.
TRNSWC	Training in soil and water conservation =1 if household received training; 0 otherwise.
WAGINC	Salary/wage income =1 if salary/wage income is most important income source for the household; 0 otherwise.
CROPINC	Crop income =1 if sale of crops other than rice is the most important income source for the household; 0 otherwise.
FMCRDT	Access to formal credit =1 if household applied for credit from at least one formal credit source; 0 otherwise.
DEPRAT	Dependency ratio = Number of children and adult dependants who don't produce enough for their subsistence/Number of working adults in the household.
DISTCNL	Average distance (kms) from the main irrigation canal to the rice plot(s) operated by the household in 2001.
SQDISTCNL	Square of the average distance (kms) from the main irrigation canal to the rice plot(s) operated by the household in 2001.
TENSEC	Tenure security =1 if household owned at least one of the rice plots it operated at DRS in 2001; 0 otherwise.
#PLOTS	Number of separate rice plots owned by the household at DRS
EXPRICE	Experience (number of years) in rice growing at DRS
EDUHH	Education (Number of years of schooling) of household head.
GENDHH	Gender of the household head =1 if Male; 0 otherwise.
VALVSTK	Value (Ushs) of livestock (cattle and oxen) owned by the household at end of 2001.
EXTWAT	Total number of extension visits received by the household in 2001 on the subject of irrigation water management.
CMTHSE	Cemented House =1 if main residential house had a cemented floor; 0 otherwise.
SAVCASH	Savings in form of cash =1 if household's primary form of saving was keeping cash with bank or at home; 0 otherwise.
SAVCAP	Saving in form of capital assets, merchandise or agricultural produce =1 if the household's primary form of saving was purchase of assets, merchandize or agricultural produce for re-sale; 0 otherwise.
INFMCRDT	Access to informal credit =1 if household applied for credit from at least one informal source; 0 otherwise.
RICEFOOD	Importance of rice as a subsistence crop =1 if rice is a major subsistence crop (constitutes 50% or more of household food consumption); 0 otherwise.
AGTRNORG	Agricultural training organization =1 if household had membership in agricultural training focused program/organization; 0 otherwise.
COMPLIANCE	Level of compliance with the bylaw of irrigation fee payment =1 if not at all; =2 if partial; =3 if full compliance
BENCOST	Perception of costs exceeding benefits of participation in collective action =1 if household perceives costs to be greater than benefits; 0 otherwise
#DEFAULTERS	Number of unpunished defaulters known by the household since 1994 when the irrigation fee bylaw was established
RICEQTY	Amount of rice (kgs) produced by the household in 2001
PRICE	Price (Ushs/kg) of rice received by the household in 2001
DISTMKT	Average distance (kms) from the rice plot(s) operated by the household to the market where rice was sold in 2001.
BLOCK 1	Household operated a rice plot on block 1 in 2001 =1; 0 otherwise
BLOCK 2	Household operated a rice plot on block 2 in 2001 =1; 0 otherwise
BLOCK 3	Household operated a rice plot on block 3 in 2001 =1; 0 otherwise
BLOCK 4	Household operated a rice plot on block 4 in 2001 =1; 0 otherwise
BLOCK 5	Household operated a rice plot on block 5 in 2001 =1; 0 otherwise
BLOCK 6	Household operated a rice plot on block 6 in 2001 =1; 0 otherwise

However, to maintain these benefits and provide incentives for farmers to continue to be efficient and competitive rice producers after the DRS management responsibility is entirely transferred to the farmers by the government will require better management and enforcement of the bylaws. Strict enforcement of the membership rules and bylaws can be an effective means of managing the use of natural resources, especially irrigation water. Weak or poorly enforced bylaws will not provide sufficient incentives for collective action in the provision of this critical public good**.**

For DRS, solving the siltation problem to increase water supply to members' rice plots requires effective fee-collection procedures, cooperation of the members towards meeting the cost of de-silting. This study examined existing regulations and incentives (benefits) for participation in collective action and found serious weaknesses that will diminish the effectiveness of the management responsibility transfer from government to DRS farmers, which was meant to improve the management of the irrigation system. First, there was limited awareness and poor enforcement of the bylaw that requires all farmers to pay irrigation fees of Ushs 5000 per acre per season. Only one-quarter of the farmers understood the bylaw and one-fifth had observed non-defaulters going unpunished.

Second, the benefits of irrigation water supply and extension received by farmers, which could serve as an incentive for participation, have deteriorated over the years. One-quarter of farmers perceived the benefits to be lower than the costs. This, coupled with limited awareness and poor enforcement of the bylaw, partially explains why some farmers did not pay the irrigation user-fee even when it was meant for their own benefit. The study results indicate a significant negative relationship between participation in collective action (compliance) and the perception that benefits are lower than the costs.

The challenge remains that, without enough farmers paying up the fees, the irrigation system cannot be adequately de-silted, which in turn lowers the amount of irrigation water supplied to the rice plots, hampering rice yields and farmers' ability to pay the irrigation fees in the following season. Therefore, failure to de-silt the canals adequately sets forth a cycle of failure. Breaking this circle will require rehabilitation of the entire irrigation systems to water supply to the farmers, who will then have incentives to improve agricultural productivity.

Once the scheme has been rehabilitated, it will be necessary to enact stronger bylaws and improve awareness about them. The study results show significant differences in compliance across the six blocks that make up DRS. Further research on the nature and extent of these block-level differences and how they influence compliance is needed to provide information on how to increase compliance on blocks where it is currently low.

Table 17. Determinants of household income share of rice (%RICEINC)

Variable	**Coefficient**	**Robust Standard Error**	$P > \|t\|$
COMPLIANCE	0.040	0.020	0.048
EDUHH	-0.021	0.113	0.062
GENDHH	-0.089	0.047	0.060
DEPRAT	0.001	0.009	0.951
#PLOTS	0.028	0.016	0.090
TENSEC	0.021	0.047	0.648
DISTCNL	-0.031	0.037	0.408
VALVSTK	-0.004	0.002	0.034
EXPRICE	0.016	0.012	0.174
CMTHSE	-0.040	0.031	0.206
SAVCASH	-0.068	0.037	0.070
SAVCAP	-0.109	0.038	0.004
FMCRDT	-0.059	0.035	0.092
RICEFOOD	-0.023	0.036	0.524
CROPINC	-0.393	0.064	0.000
AGTRNORG	0.005	0.056	0.924
INFMCRDT	-0.018	0.023	0.425
WAGINC	-0.270	0.051	0.000
TRNSWC	-0.083	0.056	0.141
RICEQTY	0.003	0.014	0.838
PRICE	-0.00002	0.0001	0.875
DISTMKT	-0.010	0.009	0.221
CONSTANT	0.741	0.135	0.000
N=	398		
$\overline{R^2}$	0.25		

The regression results suggest that households that depend on rice for a large part of their cash income are more likely to participate in collective action (payment of irrigation fees) that reduces the risk of irrigation water scarcity and its negative impact on rice harvests and income. Also having the sale of other crop produce (besides rice) as the primary income source increases compliance. This is probably because the income from these alternative sources increases the ability to pay the irrigation fees. However, rice being a major subsistence food crop does not seem to affect compliance, suggesting that producing rice primarily for subsistence needs of the household may not affect participation in collective action.

Therefore, increasing the commercialization of rice may enhance irrigation fee payment and use of better yield-enhancing inputs such as seed and fertilizer. This is consistent with the new government's plan for modernization of agriculture (PMA) (Government of Uganda, 2000). Agricultural training in soil and water conservation and access to credit sources increases compliance, showing the need for support services such as extension education and credit.

Table 18. Determinants of participation in collective action (Level of Compliance)

Variable	Coefficient	Robust Standard Error	$P>\|z\|$
%RICEINC[#]	8.712	1.611	0.000
EDUHH	-0.078	0.137	0.568
GENDHH	0.968	0.545	0.076
DEPRAT	0.200	0.099	0.044
#PLOTS	-0.484	0.164	0.003
TENSEC	-1.000	0.513	0.051
DISTCNL	0.218	1.058	0.837
SQDISTCNL	0.282	0.546	0.605
EXTWAT	0.182	0.195	0.351
TRNSWC	1.153	0.651	0.077
EXPRICE	-0.336	0.123	0.006
CMTHSE	0.619	0.363	0.088
SAVCASH	0.116	0.245	0.637
FMCRDT	0.964	0.371	0.009
RICEFOOD	0.111	0.372	0.765
CROPINC	4.693	1.067	0.000
AGTRNORG	0.869	0.681	0.202
BLOCK 1[*]	0.873	0.467	0.062
BLOCK 2[*]	1.046	0.457	0.022
BLOCK 3[*]	1.058	0.474	0.025
BLOCK 4[*]	0.700	0.435	0.107
BLOCK 5[*]	0.654	0.325	0.045
BLOCK 6[*]	0.462	0.391	0.238
BENCOST	-0.556	0.242	0.022
#DEFAULTERS	-0.012	0.240	0.961
N=	398		
Prob> χ^2	0.0000		

predicted values generated in step one of the regression analysis.
* All six block dummies were used without dummy variable trap because some households had rice plots on more than one block

These results suggest that households that depend on rice for a large part of their cash income are more likely to participate in collective action (payment of irrigation fees) that reduces the risk of irrigation water scarcity and its negative impact on rice harvests and income. Thus, the importance of rice as a cash income source is a significant determinant of the household decision to comply (pay irrigation fees). Also, having the sale of other crop produce (besides rice) as the primary income source increases compliance. This is probably because the income from these alternative crops increases the ability to pay the irrigation fees. However, rice being a major subsistence food crop does not seem to affect compliance. This suggests that producing rice primarily for subsistence needs of the household may not affect participation in collective action.
Agricultural training in soil and water conservation and access to formal credit sources also increase compliance. This underscores the importance of supporting services (extension education and credit) to increase farmers' awareness of the need to contribute towards the cost of supplying irrigation water through education, as well as their ability to contribute, through credit services.

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CHAPTER NINE

Management Regulations and Enforcement in Malawi Fisheries

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Management Regulations and Enforcement in Malawi Fisheries

1.0 INTRODUCTION

1.1 Background

Fisheries resources make a significant contribution to the economy of Malawi. In this country with high protein-related nutritional problems, about 70 percent of animal protein comes from fish. An estimated 70,000 households depend on the fishing industry as a major source of their livelihoods. The fisheries sector directly employs about 3,000 artisans, a good proportion of whom are female fish processors, and the collapse of the fishing industry will negatively impact these people.

The major proportion of fish is supplied from Lake Malawi through capture fisheries. More than 600 fish species are caught in Lake Malawi. Most them are endemic to the lake and are not found anywhere else in the world. The preference for certain species over others can be shown by the catching effort devoted to certain fisheries. For example, *Oreochromis* spp., locally known as chambo, is said to command higher prices at the market than other species and therefore encourages more entrants into the chambo fishery (Turner 1996). It is also stated that the yield of chambo from the southern part of Lake Malawi and Lake Malombe has declined by almost 94 percent, from approximately 10,000 tons in the early 1980s to about 600 tons in the 1990s.

Whereas the increase in catching effort due to preferential consumer demand for chambo is one possible reason for the decline of the chambo, other studies point to the failure to enforce management regulations as the major reason (GOM 1993). These reasons remain speculative, and unless real root causes, constraints, and threats are identified and opportunities for addressing these problems well spelt out, it is unlikely that the problem of diminishing chambo fishery will be arrested. Consequently, there are fears that by 2020 the chambo stocks will be completely extinct in Lake Malawi and Lake Malombe.

In an attempt to address the problem of declining fishes, the Government of Malawi introduced various interventions. The major one was the Participatory Fisheries Management (PFM) Program, which aimed to improve the fishery through community enforcement of fishery management regulations. This program was introduced in 1993 after the implementation of the United Nations Development Programme (UNDP)/Food and Agriculture Organization of the United Nations (FAO) Chambo Fisheries Project (1988–92), whose findings suggested that the major cause for the chambo decline was government's failure to enforce management regulations. The enforcement program was said to be top-down (from government to community) and lacked community participation. The PFM Program, which placed communities at the center, was seen to be the panacea to stock recovery.

After about a decade of PFM, the chambo fishery did not appear to be recovering. On the contrary, the fishery was still declining. Recent literature (GOM 2003) shows that total fish landings declined from about 65,000 metric tons[4] a year in the 1970s and 1980s to 50,000 tons a year in the late 1990s. The decline in fish catches has led to a decline in the contribution of fish to human protein intake of more than 50 percent, from a peak intake of 70

[4] Hereafter all tons mentioned in this report are metric tons.

percent of total animal protein during the 1970s. Of all the species, the chambo fishery has exhibited the single most significant decline. From the 1980s to 2000, there was a total production loss of about 8,000–9,000 tons per year, equivalent to a US$15 million loss in revenue to the industry, at current market prices.

The dietary and economic contributions of the chambo fishery to the nation are significant. In view of this situation, it behooves scientists to conduct studies that can form the basis for policy review and strategic planning to arrest the decline of the fishery. This study was carried out to establish the main cause of the chambo decline with the view of making recommendations on the relevant policies.

1.2 Objectives and organization of this study

Given the decline in the chambo fishery, the following questions arose: Was failure to regulate management regulations, the premise on which the PFMP was formulated, indeed the main reason for the chambo decline? Could there be other principal causes for the decline that needed policy intervention?

The overall objective of this study is to identify the causes of the decline of the chambo fishery so that appropriate policy steps can be taken. Specifically, the study was undertaken to identify principal issues associated with the decline of the chambo fishery, to characterize the various user groups and their activities in order to come up with reasons for the chambo decline, and thereafter to make appropriate recommendations for the management of the chambo fishery. The hypothesis of the study is that failure to enforce regulations on the exploitation of fishery was not the major cause of the decline in chambo fishery.

The report starts with a literature review that describes past efforts to manage the fishery through community participation and its problems. The following sections address methodology, results, discussion, and conclusions and policy implications.

2.0 LITERATURE REVIEW

The PFMP on Lakes Malawi and Malombe arose out of the chambo fishery crisis (FAO 1993). Catches had declined from about 8,300 tons in 1982 to less than 100 tons in 1994, representing a considerable income loss to fishers. The total catch value had fallen from about MK36 million in 1982 to about MK8.4 million in 1990 (Wilson 1993). This collapse of the chambo fishery was attributed to indiscriminate capture of juveniles by fine-meshed seine nets, as reported by the FAO/UNDP-funded Chambo Research Project, implemented from 1988 to 1992 in the southeast arm of Lake Malawi, the Upper Shire River, and Lake Malombe (GOM/UNDP/FAO 1995). The main reason given at the time for the proliferation of the undermeshed nets was the government’s difficulty in enforcing management regulations. The top-down management style was said to have failed. An alternative management style was therefore needed, and PFM was introduced.

PFM is a management approach in which users participate in formulating policy and managing fisheries. It proposes a dynamic relationship and division of authority and responsibilities between government and local communities. Community participation is enhanced through the establishment of Beach Village Committees (BVCs) comprising fishing communities who work with fisheries extension staff at a local level (GOM 1993).

In theory, under PFM, the government and the user community share knowledge about the fishery, which leads to review of regulations, enforcement, and observation of regulations, resulting in improved catches (Figure 1).

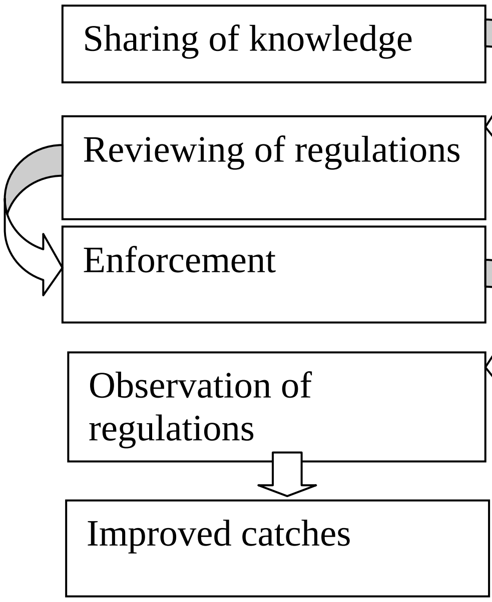

Figure 1: Concept of participatory approach

Source: NARMAP 2002.

Implementation of PFM on Lake Malombe and the Upper Shire River, and to a lesser extent on the southeast arm of Lake Malawi, involved a large number of external collaborators, including numerous international agencies (the German Agency for Technical Cooperation [GTZ] and Department for International Development (DFID), among others), and many internal government collaborators (including various ministries, the commercial Bank of Malawi, the Malawi Rural Finance Company, the Malawi Broadcasting Corporation, and others). By 1999, however, most of these collaborators had been phased out of the program, leaving only the GTZ to support it.

The major coordinating linkages in the PFMP were the Beach Village Committees (BVCs), the Ministry of Natural Resources and Environmental Affairs through the Community Liaison Unit (CLU), and the Fisheries Department. Over time the linkages have undergone enormous metamorphosis. Lower down on the chain of command, however, the newly formed Lake Malombe and Upper Shire River Fishermen's Association was created to act as an umbrella body for all BVCs and also as a link between the BVCs and the proposed Fisheries Board.

Some successes were reported from the PFM program, such as community participation in formulating new fisheries regulations as follows:

- an increased minimum mesh size of ¾ inch for nkacha and kambuzi seines was agreed to, and fishers' adoption rate of ¾-inch mesh increased from 17 percent in 1994 to 60 percent in 1995 and to 85 percent in 1996;
- a minimum mesh size of 3 inches was adopted for chambo seines and gill nets;

– a maximum head line length of 250 meters was adopted for nkacha, 500 meters for kambuzi and 1,000 meters for chambo nets; and
– a three-month closed season was adopted for fishing.

The proposed gear regulations were published as amendments to the Fisheries Act in the Malawi Gazette Supplement on June 28, 1996.

Nevertheless, evaluation studies including Donda (2001) have indicated numerous shortfalls in the PFMP. Further assessment in Hara, Donda, and Njaya (2002) focused on conflicts between the local leaders and the BVCs, limited sanctions imposed by the BVCs on illegal fishers, failure by the Fisheries Department to meet its expected obligations such as revenue sharing, and corruption among the BVCs and local leaders. Thus, in the Malawi's Department of Fisheries Strategy (2002–07) community participation is supposed to be enhanced.

3.0 RESEARCH METHODOLOGY

3.1 Study approach

The study was implemented through a series of critical steps. Initially a desk study involving stakeholders was undertaken to determine and redefine research questions and topical issues. This was followed by field studies on various chambo user groups (Figure 2).

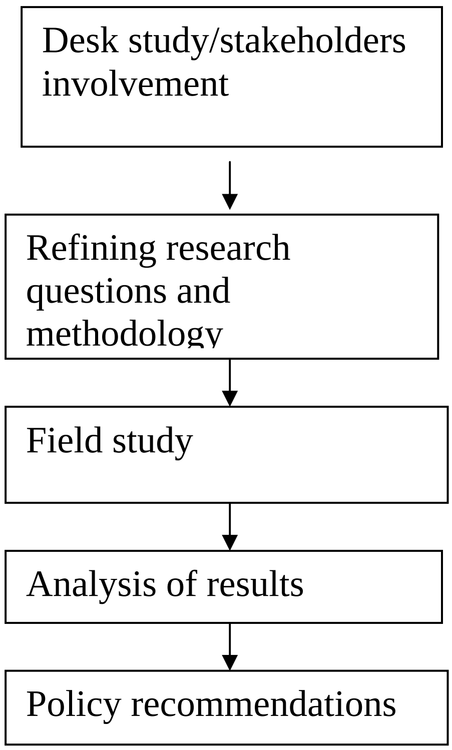

Figure 2: General approach to this study

3.2 Desk study

The desk study involved collecting secondary data and synthesizing reports mainly from the Fisheries Department and the Department of Environmental Affairs (Lilongwe and Mangochi). Chambo fish prices from 1992 were obtained from MALDECO. Observations were also made on ecological issues that influence the fisheries sector.

3.3 Field study

The field studies were conducted with various chambo user groups, including consumers, traders, gear owners, crewmembers, and communities around fishing areas. Therefore, a multipronged approach, including qualitative and quantitative methods of data collection, was employed.

The random sample consisted of 73 chambo consumers from 22 districts of Malawi and 2 districts of Zambia (Appendix A) who had responded to an advertisement. These consumers completed structured questionnaires and participated in an untrained sensory investigation at Bunda College of Agriculture, University of Malawi, to determine their consumption habits and preferences regarding chambo and other species from Lake Malawi—*Rhamphochromis* spp. (ncheni) and *Bagrus meridionalis* (kampango). Fillets of chambo, whole ncheni, and kampango were purchased from MALDECO Fisheries Ltd. The ncheni was filleted at the cafeteria. The fillets were prepared using three cooking methods: roasting, frying, and boiling. Boiled samples were smoked before being boiled. Members of the sensory panel came from the Bunda College community. The panelists (consumers) were asked to determine the most preferred species and sat for a sensory evaluation (refer to Photo C) to choose the fish samples they would prefer to eat. Parameters evaluated included appearance, using visual perception; aroma and smell, using nose; taste, juiciness, and tenderness, using mouth feel; and acceptability, using a hedonic scale.

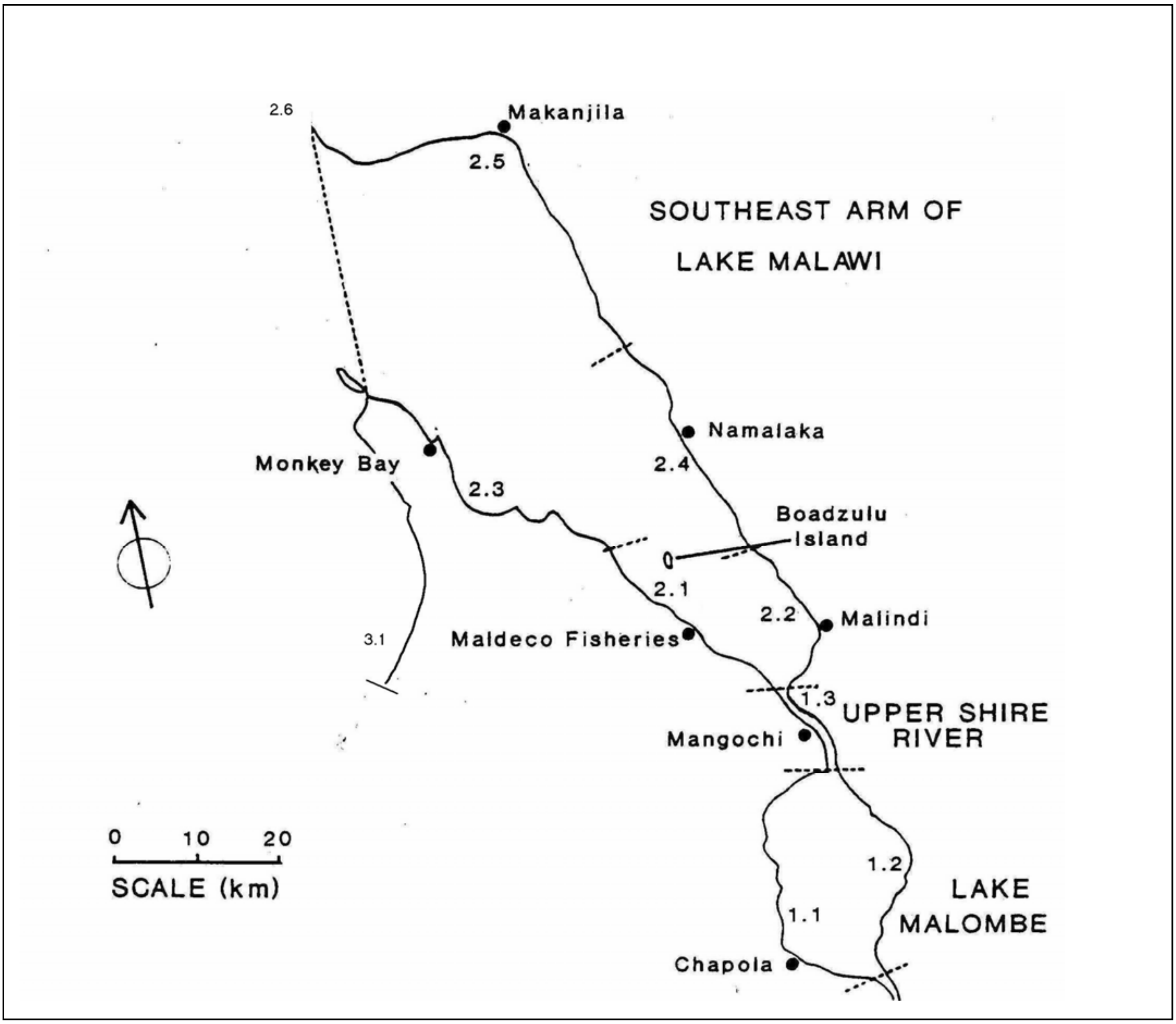

Figure 3: Map of southeast arm of Lake Malawi, Upper Shire River, and Lake Malombe, showing some BVC sites

This study was undertaken to determine whether it was a myth that chambo was the tastiest fish. If other species proved to be equally tasty, then a possibility existed for marketing species other than chambo. This would reduce the demand for chambo and save it from overfishing.

A total of 137 fish traders (103 males and 24 females) along the beaches of the southeast arm of Lake Malawi and Lake Malombe were randomly sampled and responded to structured questionnaires in September 2002. Because of the mobility of fish traders, no meaningful stratification of sampling program could be made.

Again, owing to mobility, 72 gear owners and 104 crew members randomly sampled along the beaches stated above responded to structured questionnaires during the same period.

Table 1: Number and gender of individuals that were interviewed either singly or in focus group discussions

Date	Area	Lake	BVC members		Members of other institutions	
			Male	Female	Male	Female
19/09/02	Mtenje	Lake Malombe (W)	3	1	6	2
19/09/02	Mtanga	Lake Malombe (W)	7	3	3	2
19/09/02	Chiwaula	Lake Malombe (W)	5	2	2	1
19/09/02	Chizumbi	Lake Malombe (W)	4	5	5	3
20/09/02	Likulungwa	Lake Malombe (E)	7	3	6	2
20/09/02	Sili	Lake Malombe (E)	6	4	6	4
20/09/02	Ng'ombe	SEA Lake Malawi (E)	9	1	2	2
20/09/02	Kadango	SEA Lake Malawi (E)	10	0	4	2
21/09/02	Nkali/ Chipoka	SEA Lake Malawi (W)	4	1	4	9
21/09/02	Kela/ Makawa	SEA Lake Malawi (W)	6	3	4	2
		TOTAL	61	23	42	29

Through focus group discussions, qualitative data were collected from 10 randomly selected sites or beaches along the shores of Lake Malombe and the southeast arm of Lake Malawi. The sites included Chizumbi, Mtanga, Ntenje, Chimwala, Likulungwa, and Sili along Lake Malombe and Kadango, Ng'ombe, Nkali, and Kela/Makawa on the southeast arm of Lake Malawi (Figure 3). These communities included those belonging to community institutions. Focus group discussions (FDGs) for people belonging to BVCs were conducted separately from FDGs for other institutions so that they could provide an independent perspective on BVCs and the chambo fishery. Other institutions included health and natural resources institutions. A total of 163 people (107 men and 56 women) were interviewed (Table 1).

Guidelines were used to help interviewers keep track of the discussion. Flip charts, pencils, and markers were used to help people explain their ideas when verbal communication was difficult. Using these materials, people were able to illustrate historical trends such as changes in shoreline vegetation and fish catches.

3.4 Data analysis

Quantitative data were analyzed used Statistical Package for Social Scientists (SPSS), Version 7, software package, where descriptive statistics were used to characterize fish consumers, fishing communities, and traders. In FDGs, answers were coded for key questions and noted for each BVC or group and summarized in table form.

4.0 RESULTS AND DISCUSSIONS

4.1 Possible reasons for the decline of the chambo fishery

From the desk and field studies, several reasons came up as possible reasons for the cause of the chambo fishery decline, including an increase in the number of entrants into the fishery, noncompliance with fisheries regulations (such as use of illegal gear), poverty, preferential demand for chambo, destruction of breeding grounds, environmental degradation causing siltation, and weather changes (Figure 4).

4.1.1 Increase in number of entrants into the fishery

An increase in the number of fishers and fishing gears had been reported as one of the fundamental reasons for the decline of the chambo fishery (EAD 2000). These sentiments were corroborated by findings in this study, where 64 percent of the gear owners attributed the decline to the proliferation of fishers and fishing gears on the lakes (Table 2). A good proportion of the respondents (18 percent) mentioned changes in weather as the causative factor.

Table 2: Reasons for decline of chambo catches given by gear owners from Lakes Malawi and Malombe

Reason for chambo decline	Frequency	Percentage
Increased number of fishing gears	61	64
Weather change	18	19
Use of lamps and engines	3	3
Use of illegal gears	5	5
Just nature	9	9

Similarly, in the FGDs with all the BVCs (Table 3) and members of other institutions (Appendix B), the high number of fishers was mentioned as an important reason for the chambo decline.

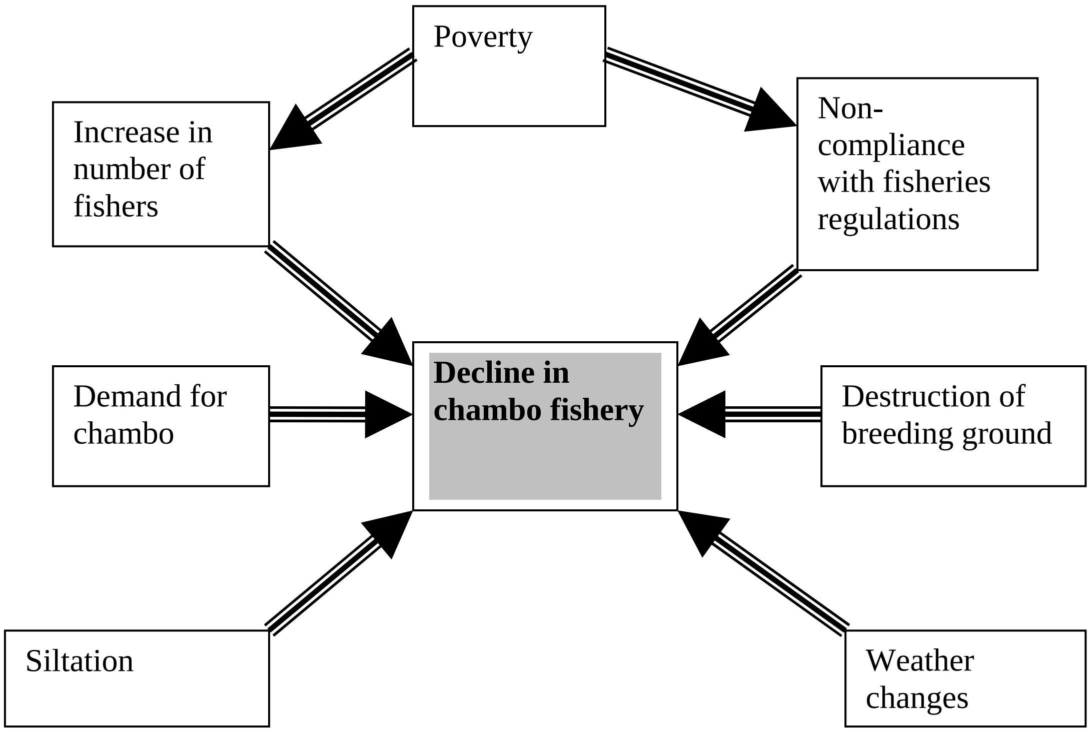

Figure 4: Possible causes of the decline of the chambo fishery

Table 3: Reasons for the decline of chambo fishery as given by members of the Beach Village Committees

	BVC									
	Lake Malombe						Lake Malawi			
Reasons given for fish decline	Chiwa ula	Mtenje	Ntan ga	Chizu mbi	Silli	Likulun gwa	Kadango	Ng'om be	Nkali	Kera/ Maka wa
Too many fishers	*	*	*	*	*	*	*	*	*	*
Poverty (land cannot give enough food)	*	*	*	*	*	*	*	*	*	*
Use of illegal gears	*	*	*	*	*	*	*	*	*	*
Failure of government to control manufacturing of undermeshed gears					*	*				

Note: * indicates where the reason was mentioned during a focus group discussion.

The numbers of fishing gears in Lakes Malawi and Malombe is said to have doubled since 1995 (GOM 1993). There is no limit to the number of licenses issued, and the fishery is “open access”—that is, free to all entrants.

4.1.2 Noncompliance with fisheries regulations (such as use of illegal gears)

PFM was principally introduced because it was perceived that fishers could not comply with fisheries regulations, like bans on the use of illegal gears and fishing during closed seasons. Interestingly, in this study, only a few gear owners (5 percent) attributed the chambo decline to use of illegal gears (Table 2), whereas all the BVCs noted this as a problem (Table 3). The fact that there is still noncompliance with the fisheries regulations even after introduction of PFM means that the BVCs may not have been effective. When asked why people did not comply with fisheries regulations, the majority of the gear owners interviewed (40 percent) gave poverty as the reason (Table 4).

Table 4: Reasons given by the gear owners for not complying with fisheries regulations

Reasons for not complying with fisheries regulations	**Frequency**	**Percentage**
Poverty	48	46
Negligence	16	15
Lack of knowledge of importance of regulations	13	13
People are just troublesome	7	7
Reasons not known	7	7
Most people do comply	6	6
Nobody goes against regulations	4	4
Corruption	2	2
People do not advise each other	1	1

4.1.2 Poverty

Gear owners and members of BVCs gave poverty as a reason why people failed to comply with management regulations and why more went into fishing: “land can’t give enough food!” (Tables 3 and 4). Similarly, GOM (2003) observed that owing to poverty and limited economic opportunities elsewhere, crop failure, and drought, more and more people, enticed by rising fish prices, entered the fishery as an alternative income-generating activity. Perhaps this explains why when asked about possible ways to curb overfishing, BVC members suggested offering loans to start other businesses (Table 5).

Table 5: Responses given by various Beach Village Committees on how to curb the problem of overfishing

Suggested solutions to the problem of overfishing	BVCs along Lake Malombe						BVCs along Lake Malawi			
	CHW	MTE	NTA	CHZ	SL	LK	KD	NG	NK	KE
Have government help people get loans	*	*	*	*	*	*	*	*	*	*
Eliminate fishing during closed season	*	*	*	*	*	*	*	*	*	*
Eliminate corruption	*	*	*	*	*	*	*	*	*	*
Give nets to owners so they do not use undermeshed nets		*	*	*						
Limit the number of fishers operating in the area				*						
Introduce irrigation					*					
Introduce fish farming	*						*	*	*	*
Introduce closed season for MALDECO										
Increase cooperation and unity among institutions	*	*	*	*	*	*	*		*	*
Extend closed season to 2–3 years					*	*			*	
Toughen enforcement on regulations; seize all chambo fished in closed season		*	*			*	*		*	*
Have frequent BVC meetings			*		*			*	*	*
Train BVC members	*	*	*	*	*	*	*	*	*	*
Dump old cars in the lake to create sanctuaries									*	

Note: CHW = Chiwaula; NTA = Ntanga; CHZ = Chizumbi; LK = Likulungwa; KD = Kadango; NG = Ng'ombe; NK = Nkali; KE = Kera/Makawa.

Another question then arose: who are the poor who need loans to start alternative income-generating activities? Why did past efforts to introduce income-generating activities not help reduce entry into the fishery? Further investigation showed that both gear owners and crew members depended heavily on fishing for their livelihoods (Figures 5 and 6).

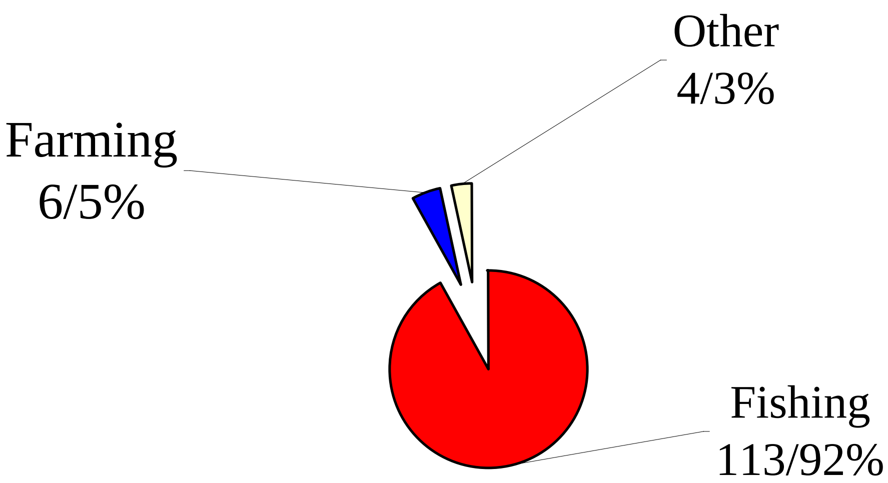

Figure 5: Major source of livelihood for gear owners

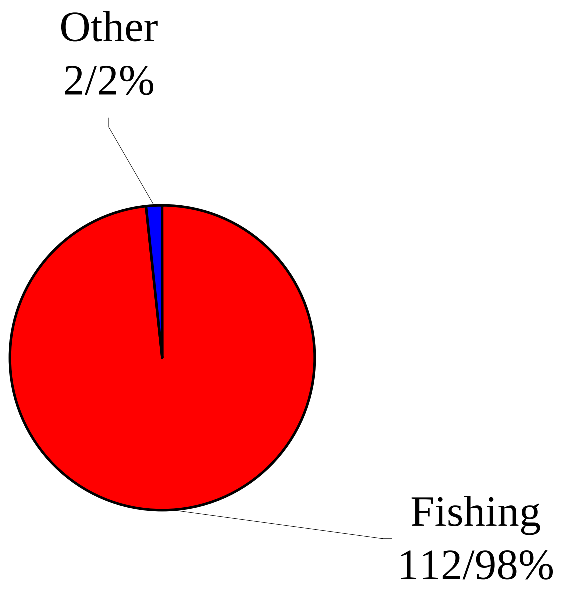

Figure 6: Major source of livelihood for crew members

The results also showed that whereas both gear owners and crew members stated that fishing was their source of livelihood, gear owners had much higher incomes than crew members. The income obtained from various gears in Table 6 is shared between gear owners and crew members, with each of the latter getting about 10 percent of the income.

Table 6: Incomes from various gears in Lakes Malawi and Malombe

Gear type	Average quantity of fish caught				Average income (MK/gear/day)			
	Lake Malawi	n	Lake Malombe	n	Lake Malawi	n	Lake Malombe	n
Chilimira	50 tins + 2 dozen	35			12,284	30		
Nkacha	38 tin + 2.8 dozen	7	32 tins + 1.4 dozen	31	8,559	30	1,510	30
Gill nets	6.2 tins+ 11 dozen	28	5.8 tins + 13 dozen	21	1,575	30	893	30
Kandwindwi	20 tins + 3 dozen	2			7,500	30		
Seine nets	20 dozen	1						
Chikokweza	18 tins + 10 dozen	2						

Note: Incomes presented took into account fixed and variable costs. MK = Malawi kwacha. At the time of the study, approximately MK70 = US$1. n is sample size

Gear owners hire crew members and pay them based on the catch. Usually the whole crew is paid half the income from the day's catch, which is shared among them. The number of crew members depends on gear type. A single person would operate a gill net, whereas chilimira and nkacha may employ up to 8 persons. Chilimira are open seine nets, usually 30–40 meters long and 10–15 meters wide. After the day's fishing the crew members are entitled to a proportional wage and a limited amount of fish for relish. They are supposed to get their wages after the catch is sold (see Photo B). For example, if the gear owner is paid MK1, 510 (that is, the average income for nkacha in Lake Malombe) and there are 7 members in the crew, each one gets only MK108 (about US$1.5 for the day) whereas the gear owner gets about US$11 for the day.

4.1.4 Habitat destruction and environmental degradation

A number of reports suggest that habitat degradation is one important factor responsible for chambo decline. Degradation could result either from destructive fishing practices, such as use of seine nets, or from development of resorts and cottages along the beaches (Njaya and Chimatiro 1999).

Removal of submerged aquatic vegetation beds in shallow areas exposes juvenile chambo to predation (GOM 2003). All these reports are anecdotal, but during the study the fishermen noted that relatively higher catches were obtained along the eastern bank of the southeast arm of Lake Malawi, where vegetation was still intact along the shoreline.

4.1.5 Siltation

Siltation is said to affect the breeding of chambo (EAD 2000), but no quantitative studies have been made to relate siltation to the decline in chambo fishery. Siltation is much more prevalent in the catchments area of Lake Malombe.

4.1.6 Weather changes

Nineteen percent of the gear owners that were interviewed (Table 2) attributed the decline in chambo fishery to changes in weather. While no studies have been conducted to determine the weather effects on a fishery, the combined effects of increasing temperatures and decreased wind speed have been said to stabilize the waters of Lake Tanganyika and reduced the water mixing. This is said to diminish productivity in Lake Tanganyika, resulting in fish yields about 30 percent lower (Plisnier 1997). There is a need to study the effects of weather and climatic changes on the chambo fishery.

4.1.7 High demand for chambo

Chambo is said to be more popular, and therefore to command higher prices at the market, than other species. This situation is said to encourage more entrants into the chambo fishery (Turner 1996). The higher market prices were confirmed with data obtained from MALDECO, the main fishing and marketing company. The prices of all other species were lower than that of chambo except for usipa ***(*Engraucypris sardella*),*** which had the same ***price a few times (Figure 9).***

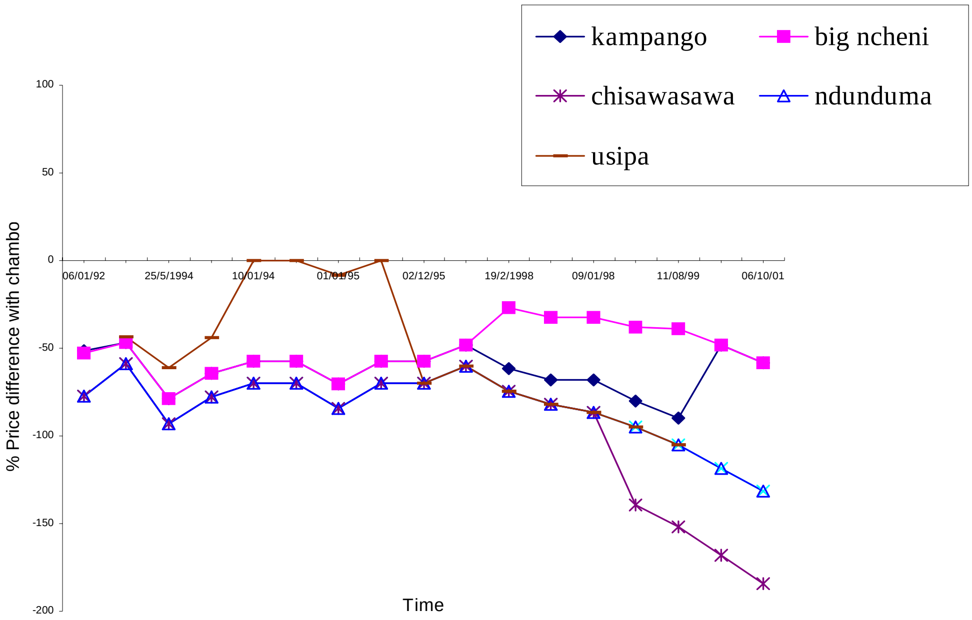

Figure 9: Differences in prices (as a percentage) between fresh chambo and other species at MALDECO (1992–2001)
Note: A negative price difference means a lower price than that of chambo.

These results were confirmed by interviews with fish traders, the majority of whom mentioned that chambo fetched higher prices than any other species (Figure 10).

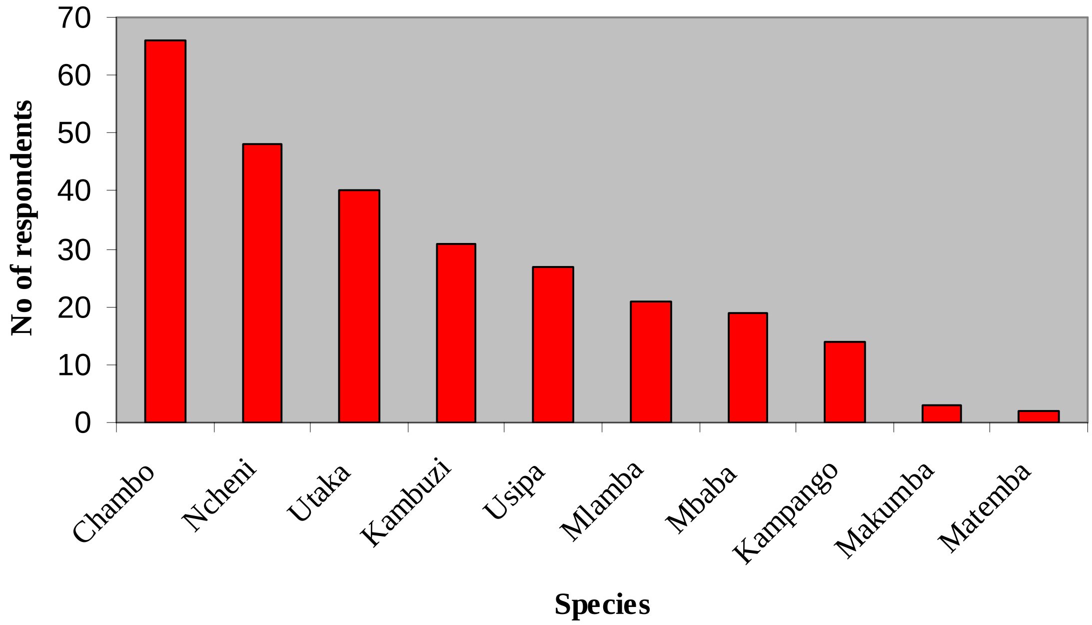

Figure 10: Number of respondents who mentioned that a particular species fetched the highest prices at market

The reason for the preference for chambo is not the taste of chambo. In a study of consumers, while the majority of the respondents stated that they did prefer chambo to other species (Figure 11), the majority preferred the appearance (93 percent), aroma (77 percent), tenderness (60 percent), juiciness (68 percent), and taste (65 percent) of fried ncheni (Rhamphochromis spp.) (Table 7).

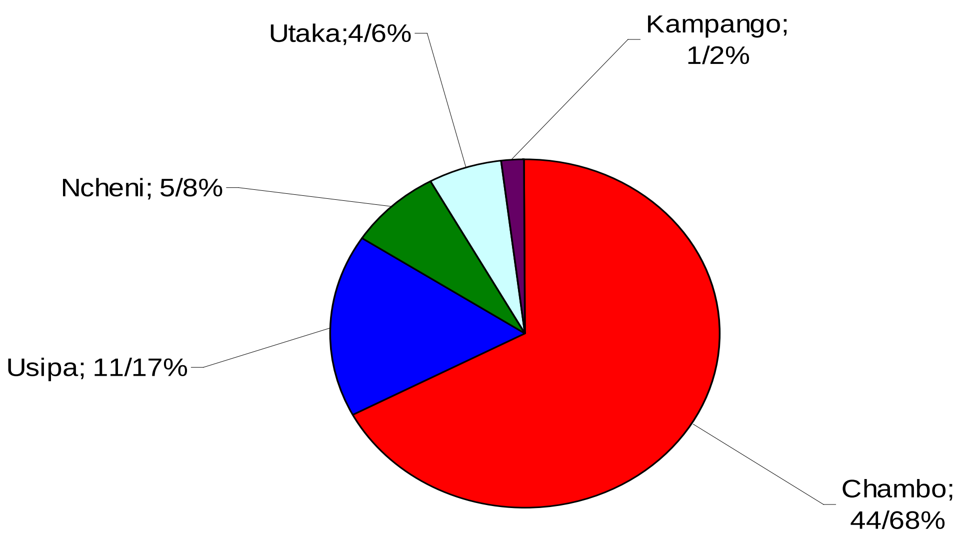

Figure 11: Percentage of the respondents who ranked a particular species as the most preferred species

Table 7: Percentage of respondents who indicated appearance, aroma, tenderness, juiciness, and taste of various fish samples as first choice

Sample	Percentage of respondents who ranked fish sample as first choice based on:				
	Appearance	**Aroma**	**Tenderness**	**Juiciness**	**Taste**
Fried chambo	75	54	48	55	52
Roasted chambo	67	50	44	60	62
Smoked chambo[a]	33	33	45	68	30
Fried ncheni	93	77	60	68	65
Roasted ncheni	55	54	66	62	56
Smoked ncheni[a]	25	15	45	55	18
Fried kampango	74	48	36	43	48
Roasted kampango	62	65	47	59	58
Smoked kampango[a]	43	38	78	44	53

Note:* N *ranged between 40 and 71.

[a]Samples were smoked, then boiled.

4.2 Why PFM may not have worked

While PFM was seen as a panacea that would arrest the demise of the chambo through increased enforcement of regulations through the BVCs, PFM did not deliver the goods. The literature and the field study suggest several possible reasons.

4.2.1 Lack of property rights

Reports from the Malawi Fisheries Department suggest that the 10 years of PFM failed to halt the demise of the chambo because the BVCs were not empowered by legal status and had neither legal rights nor the ability to enforce regulations. It is argued that the fishers should be given effective property rights so they can own and protect exclusive zones of Lake Malawi and Lake Malombe (GOM 2003).

4.2.2 Exogenous origins of PFM

Contrary to the premise on which PFM was established, fishers and communities generally perceived the BVCs as institutions of the state that worked on behalf of the state. In some cases BVC members expected to be given incentives, such as allowances, by the Fisheries Department during meetings (Table 5). This situation is unlike that in Lake Chiuta, where PFM has successfully achieved its goals because the need for the formation of the enforcement committee was endogenous (Njaya 2002).

4.2.3 Lack of attention to social issues

Tied to the fact that the BVCs are perceived as exogenous is the failure to take account of social relationships within the society when the BVCs were introduced. Given the lack of an in-depth understanding of local sociodynamics, the institution of BVCs in Lake Malombe has led to a power struggle between village headmen (local leaders) and BVCs (Hara, Donda, and Njaya 2002). Moreover, the Fisheries Department, village leaders, and fishing community pull the BVCs in different directions. As noted by Hara, Donda, and Njaya (2002), the BVCs were not occupying a power vacuum, and some of the roles and functions of BVCs infringed on the powers, authority, and economic privileges of the traditional leaders such as village headmen. Consequently, migrant fisher folk must now seek permission and pay *mawe* (informal taxes) to both the village headman and members of the BVCs.

4.2.4 Organizational structure

When the BVCs were initially formed little thought was given to the organizational structure. There was low representation of the fishing industry (gear owners, marketers, etc.). As a result, the BVCs lack direction and are unable to agree on management objectives and strategies (Allison and Mvula 2002). In addition, poor representation by the fishers means that the members of BVCs do not appreciate the problems and needs of the fishers.

4.2.5 Lack of understanding of the roles of the BVCs

There is a lack of understanding of the roles of the BVCs. According to Fisheries Department, BVCs were originally envisaged as strong, independent bodies that could eventually assume delegated management responsibilities from the government. Their roles were to:

- act as intermediaries between the Department of Fisheries (DoF) and fisher communities;
- assist DoF in licensing gears;
- enforce fishing regulations such as minimum mesh sizes and closed seasons;
- participate in the formulation of fishing regulations;
- check formality of transfer of fishers;
- formulate and implement informal fishing regulations for fishers at the beaches;
- advise and tell people about the future of the fishery; and
- conduct meetings with fishers to tell them about fishing regulations.

Results from the study suggest, however, that BVC members believed that they worked for the Fisheries Department and therefore needed to be paid. Miting’i yo popanda posayina! (No meeting without signing for an allowance!), one member of the BVC complained during the interviews.

5.0 CONCLUSIONS AND POLICY IMPLICATIONS

This study has established that the chambo decline has many causes apart from the failure to enforce management regulations. Following the decline of the fishery, the Fisheries

Department formulated a Chambo Restoration Strategic Plan, in which it is stated that a review of policies is needed to:

1. establish the legal status of BVCs, enabling them to enforce the law in co-management with DoF, and institutionalise the administrative structure of District Assemblies and local authorities (i.e., Area Management Committees);
2. under the Lands Act, assign exclusive fishing zones to BVCs and Area Management Committees, as well as the right to limit entry of additional fishers;
3. establish protected areas and sanctuaries, and confer upon communities the right to protect areas in line with approved Area Management Plans;
4. encourage private sector and foreign investment in aquaculture, and provide fiscal incentives to investors for research to pioneer new production systems for chambo; and
5. establish a code of conduct in line with FAO Regulations for Responsible Aquaculture, to regulate the fisheries and aquaculture sector in Malawi, especially to control introductions and convey rights for cage farming.

While the suggested policy reviews in (1) and (2) above aim at empowering BVCs and increasing ownership of the resources to limit additional fishers, they fall short of addressing the causes of the fishery decline. For example, clarifying the legal status of BVCs may not assist in enforcing the law. This enforcement role of BVCs would entail providing resources for BVCs, a step that was perhaps not the intention of co-management. Similarly, providing exclusive zones as a way to limiting entry into may not be a solution where people do not abide by the law. Instead, the following steps are suggested:

5.1 Increase ownership of BVC and the PFM program

This and previous studies have shown that BVCs are exogenous to the system. They appear to be imposed, and power struggles do exist. Empowering these institutions, therefore, may not help. Careful study is needed to understand power relations and to determine how BVCs or similar institutions can become owned by the communities. The findings of this study can be incorporated into a policy review. The communities must see the need for the intervention. All efforts to bestow user rights upon the BVCs are bound to fail if such a perception is not achieved.

5.2 Provide targeted income-generating activities

There will be no headway in solving the problem of increasing entry into the fishery if poverty issues are not tackled. Past efforts to provide income-generating activities to gear owners proved futile because the target was wrong. There is hardly a substitute activity that could provide as much income to gear owners as fishing. Targeting crew members, however, may reduce entry into the fishery. One typical case noted during the study was a chilimira owner who had hung up his fishing gear because his crew members got jobs with a road construction company in the area.

In some cases, licenses are used to limit entry into the fishery. Where enforcement is limited, however, licenses do not work. For example, people on Lake Malawi, though not allowed to use nkacha, used their relations from Lake Malombe to get licenses and operated nkacha on Lake Malawi waters.

5.3 Regulate the construction of resorts and cottages on the eastern arm of Lake Malawi

While reports on the negative effects of cottages and resorts are anecdotal, no policy has ever mentioned ways to restore destroyed habitat or prevent further degradation in areas that are still intact. The reeds and vegetation along the shores of the eastern part of the southeast arm of Lake Malawi are a refuge breeding area for the remaining chambo, according to fishermen. A policy requiring intensive environmental impact assessments before construction of resorts would put in place measures to mitigate the removal of reeds and vegetation. Until recently, the area was impassable owing to poor road conditions, but a new tarmac road has made it accessible. Interviews with one chief (Chief Ng'ombe) indicated that interested investors had already been to the area to consider possible resort and cottage buildings.

5.4 Make a deliberate attempt to market species other than chambo

The popularity of chambo may not be related to its taste, tenderness, and juiciness compared with other species such as ncheni. While favorable sensory and taste ratings do not directly translate to the purchase, consumption, or market success of a particular product (Garber, Hyatt, and Starr 2003), with proper marketing strategies other species can replace chambo as "the species" for Malawi, thereby reducing demand for and fishing pressure on chambo.

5.5 Harmonize small-scale and large-scale commercial operators

All the BVCs along Lake Malawi indirectly blamed MALDECO fisheries as the culprit behind the overfishing of chambo and proposed that the company should also have a closed season. (   ). In some cases community members believe they are being unfairly told not to fish, as they are "small" and can therefore do no harm to the fishery. As long as this perception continues, there is little that the communities would change. Their attitude is, "If we do not go fishing, MALDECO will finish the stocks."

5.6 Curb corruption

Corruption was mentioned by people in all the BVCs as a problem. This corruption affects Fisheries Department staff to BVC leaders. Strategies should be put in place to curb corruption. If corruption remains rampant, empowering BVCs with legal status will be worthless.

5.7 Support aquaculture activities

The policy review suggested in (4) is highly encouraged here. It is apparent that chambo prices continue to escalate in the face of its limited supply. This means that any marginal increase in the cost of additional fishing gear may easily be compensated for by high price of chambo. One can thus make profits even if the number of fishing gears increases to a point where the fishery becomes almost extinct. Increasing the supply of chambo through other means, such as aquaculture, may be one solution to the problem. Recently, it was reported that MALDECO Fisheries conducted trials to culture chambo in cages, and anecdotal reports stated that growth of chambo was high in cages. An enabling policy for large-scale and small-scale aquaculture operators along Lake Malawi and Lake Malombe may ensure high supply of chambo and reduced prices for chambo that may translate into reduced entry into the fishery.

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APPENDIXES

Appendix A: Districts of origin of respondents in the sensory panel

District	Number of respondents	Percentage (%)
Lilongwe	7	10
Mulanje	3	4
Mzimba	9	12
Dowa	5	7
Chiradzulu	2	3
Likoma	2	3
Chipata, Zambia	2	3
Mchinji	1	1
Dedza	1	1
Balaka	1	1
Nkhatabay	1	1
Nsanje	5	7
Mchinji	1	1
Blantyre	2	3
Mangochi	1	1
Kasungu	2	3
Thyolo	3	4
Zomba	6	8
Rumphi	5	7
Chitipa	4	5
Ntcheu	5	7
Karonga	4	5
Nchelenge, Zambia	1	1
Total	73	100

Appendix B: Results from Focus group discussions (FGDs) of members of Beach Village Committees (BVCs)

	Different places where BVC members were interviewed									
Questions and responses	Chiwaula	Mtenje	Ntanga	Chizumbi	Silli	Likulungwa	Kadango	Ng'ombe	Nkali	Kera/ Makawa
What do you think is the status of fishery in your area?										
Declining	X	X	X	X	X	X	X	X	X	X
Static										
Fluctuating										
Which fish species is declining most										
Chambo	X	X	X	X	X	X	X	X	X	X
Kampango					X	X		X		
Ntchla	X	X	X	X	X	X	X	X	X	X
Mpasa							X	X	X	
Utaka										
Sawasawa							X	X	X	X
Kambuzi										
What are the reasons for the fish decline?										
Poverty – land can't give enough food	X	X	X	X	X	X				
Too many fishers	X	X	X	X	X	X	X	X	X	X
Use of illegal gears	X	X	X	X	X	X	X	X	X	X
Failure of government to control manufacturing of under meshed gears					X	X				X
How can we solve this problem?										

	Different places where BVC members were interviewed									
Questions and responses	Chiwaula	Mtenje	Ntanga	Chizumbi	Silli	Likulungwa	Kadango	Ng'ombe	Nkali	Kera/ Makawa
Government to assist people to get loans	X	X	X	X	X	X	X	X	X	X
No one should fish during closed season	X	X	X	X	X	X	X	X	X	X
No corruption	X	X	X	X	X	X	X	X	X	X
Nets given to owners should not have under meshed bunt		X	X	X						
Limit the number of fishers operating in the area				X						
Introduction of irrigation					X					
Introduction of fish farming	X									
MALDECO to have closed season							X	X	X	X
Need to co-operate and institutions to be united	X	x	x	X	x	x	X		X	X
Extend closed season to 2 – 3 years					X	X			X	
Tough enforcement on regulations- seize all chambo in closed season		X	X			X	X		X	X
Frequent BVC meetings			X		X			X	X	X
Training of BVC	X	X	X	X	X	X	X	X	X	X
Old cars to be damped in the lake to create sanctuaries									X	

	Different places where BVC members were interviewed									
Questions and responses	Chiwaula	Mtenje	Ntanga	Chizumbi	Silli	Likulungwa	Kadango	Ng'ombe	Nkali	Kera/ Makawa
What are your roles as BVC members?										
Patrolling along the beaches							X		X	X
Confiscation of nets and taking offenders to village headman									X	
Conducting awareness meetings									X	X
Checking if fishers are fishing during closed season	X	X	X	X	X	X	X			
To support fisheries in fish conservation			X				X			
Checking under meshed Chambo							X			
What problems do you face in BVCs**?**										
Lack of resources for patrolling	X	X	X	X	X	X	X	X	X	X
No incentives e. g uniforms, identity cards, *kangachepe* (a small token e.g. allowance)	X						X			
Insults from fishers									X	

	Different places where BVC members were interviewed									
Questions and responses	Chiwaula	Mtenje	Ntanga	Chizumbi	Silli	Likulungwa	Kadango	Ng'ombe	Nkali	Kera/ Makawa
Lack of cooperation among members				X			X		X	
Lack of training	X			X					X	
Some of the members are corrupt							X		X	
How can these problems be solved?										
BVC members should be trained	X	X	X	X	X	X	X	X	X	X
BVCs should be given resources for proper patrolling			X	X	X	X	X		X	X
They should be given incentives e.g. uniforms, identity cards etc.	X	X	X	X	X	X	X			
They should be given allowances during meetings					X		X			
Why do people use illegal gears?										
Poverty	X	X	X	X	X	X	X	X	X	X
Hunger	X	X	X	X	X	X	X	X	X	X
Decline of chambo					X	X				
High demand of fish										

Part Four – Marginal Areas

CHAPTER TEN

Animal Health Service Delivery Systems in Kenya's Marginal Areas

Lawrence Godiah Mugunieri, John Moturi Omiti, and Patrick Irungu

Animal Health Service Delivery Systems in Kenya's Marginal Areas

1.0 INTRODUCTION

1.1 Background

Livestock health service delivery in many developing countries is undergoing privatization as part of an international restructuring for economic development. One widely publicized initiative to refocus livestock health service delivery has been the introduction of community-based animal health workers (CBAHWs). This initiative involves training community-selected representatives in basic animal health care and livestock production techniques. The primary objective is to supplement and support the existing but overstretched professional system for delivering such services to communities in marginal areas of many developing countries.

Community-based livestock services in developing countries have received increasing attention during the past decade. This attention has come not only from the communities concerned, but also from international agencies such as Food and Agriculture Organization of the United Nations (FAO) (FAO 1997; Jackson and Ward 1999), the German Agency for Technical Co-operation (GTZ) (Kleemann 1999), the United Kingdom's Department for International Development (DfID) (Holden 1997), and the World Bank (De Haan and Bekure 1991).

The concept of community participation and its role in animal health services delivery has been reviewed (Leyland 1991; Catley and Leyland 2001; Oakeley 2001). Relevant stakeholder workshops have been organized to facilitate development of community-based projects in dry-land areas of Chad, Ethiopia, Kenya, Sudan, Uganda, and Tanzania (Young 1992). Experiences from community-based approaches have frequently appeared in the informal development literature. The *Arid Lands Information Network* has published experiences from Chad (Hammel 1995), Kenya (Grant 1992), and Senegal (Obel-Lawson 1992). The 1993 issue of *Journal of Appropriate Technology* was dedicated to community-based animal health, and it describes experiences from Afghanistan (Leyland 1993), Chad (Peters 1993), Kenya (Blakeway 1993), and Sudan (Dahir 1993). The role of CBAHWs in the Central African Republic, Chad, Niger, and Somalia has been reviewed (De Haan and Bekure 1991). They have concluded that community-based approaches offer a viable alternative to the resource-constrained and poorly functioning public veterinary services in developing countries. Other similar programs documented outside Africa include the village animal health workers in Nepal (Moktan, Mitchelhill, and Joshi 1990), the Anyamara veterinary technicians in southern Peru (Johnson and Chahuares 1990), and the village-based parasite control program for swamp buffalo in Thailand (Meemark 1988).

In implementing these community-based programs, different countries have adopted different approaches, presumably to tailor the programs to the specific needs of livestock farmers in varied environments. Although numerous terms have been used to describe these differing programs, Hüttner et al. (2001) and Oakeley (2001) have emphasized that most of them share similar features and goals such as:

- Individuals are selected for training by the communities within which they work;

- Technical training in animal health is short, usually less than a month;

- Low-cost strategies concentrate mainly on important livestock health and management issues of the farming community; and

- Payment for services provided comes directly from clients.

Experiences from these programs indicate that, by using existing traditional knowledge, CBAHW programs encourage the participation of the local communities in the design and delivery of animal health care services. The CBAHW model also empowers the local people to determine the type of animal health services they receive. In some areas conditions may exist that would permit full privatization using this approach. This community-based approach has shown that pastoralists and agropastoralists, for example, can organize themselves to select CBAHWs for training and offer animal health services.

In many areas where these programs have been developed, however, no accompanying studies have been undertaken to assess their impact and to establish factors that may influence their success and sustainability. These community-based projects have tended not to collect quantitative data because of resource and logistical constraints, and the need to demonstrate positive impact on animal health to local communities is becoming more apparent. CBAHW programs have become crucial yet controversial components of the privatization design (FAO 1997). This study addresses this gap in the literature by assessing the impact of this community-based approach on animal health service delivery, with the objective of evaluating it as a model of animal health delivery in arid lands of the developing world.

1.2 Objectives of the study

The overall objective of this study is to produce information that can strengthen policies for facilitating viable and sustainable CBAHW programs for efficient delivery of animal health services in arid lands of Kenya. Specifically, this study was aimed at:

- Documenting the evolution and structure of CBAHW programs following the privatization of animal health services;

- Assessing the performance of CBAHW programs in the delivery of animal health in arid and semi-arid lands (ASAL);

- Assessing the investment opportunities in informal animal health delivery systems in ASAL; and

- Offering suggestions for policy changes to improve animal health delivery systems in ASAL.

Several CBAHWs programmes have been established and docyumented in Kenya which provided a wide range of information on their operations.

1.3 Area of study

The CBAHWs studied are based in Mtito Andei division, one of the 14 divisions in Makueni district, which lies approximately midway on the Mombasa -Nairobi road (Figure 1). The region is semi-arid and is covered with dense shrub vegetation. Farmers practice rain-fed agriculture and keep varying sizes of flocks of sheep and herds of goats and cattle. This area borders the Tsavo National Park and suffers from a high level of tick-borne disease and trypanosomiasis transmitted from the park by ticks and tsetse flies respectively.

Makueni district is one of the 12 districts in the Eastern Province of Kenya covering an area of 7,440 square kilometers. It is divided into 14 administrative divisions and 52 locations. It is generally low lying and rises in altitude from 600meters at Tsavo in the east to about 1,900 meters in the Kilungu hills in the west. A large part of this district is of low agricultural potential. Major livestock products, in order of economic importance, are beef, hides and skins, goat and sheep meat, honey, chicken, and eggs.

Crop farming is mainly for subsistence purposes. The main crops grown in the area are maize, pigeon peas, and cowpeas. Irrigated horticultural farming also takes place in smallholdings along some rivers. The main cash crops include coffee and cotton and are mainly found in the high-potential parts of the district.

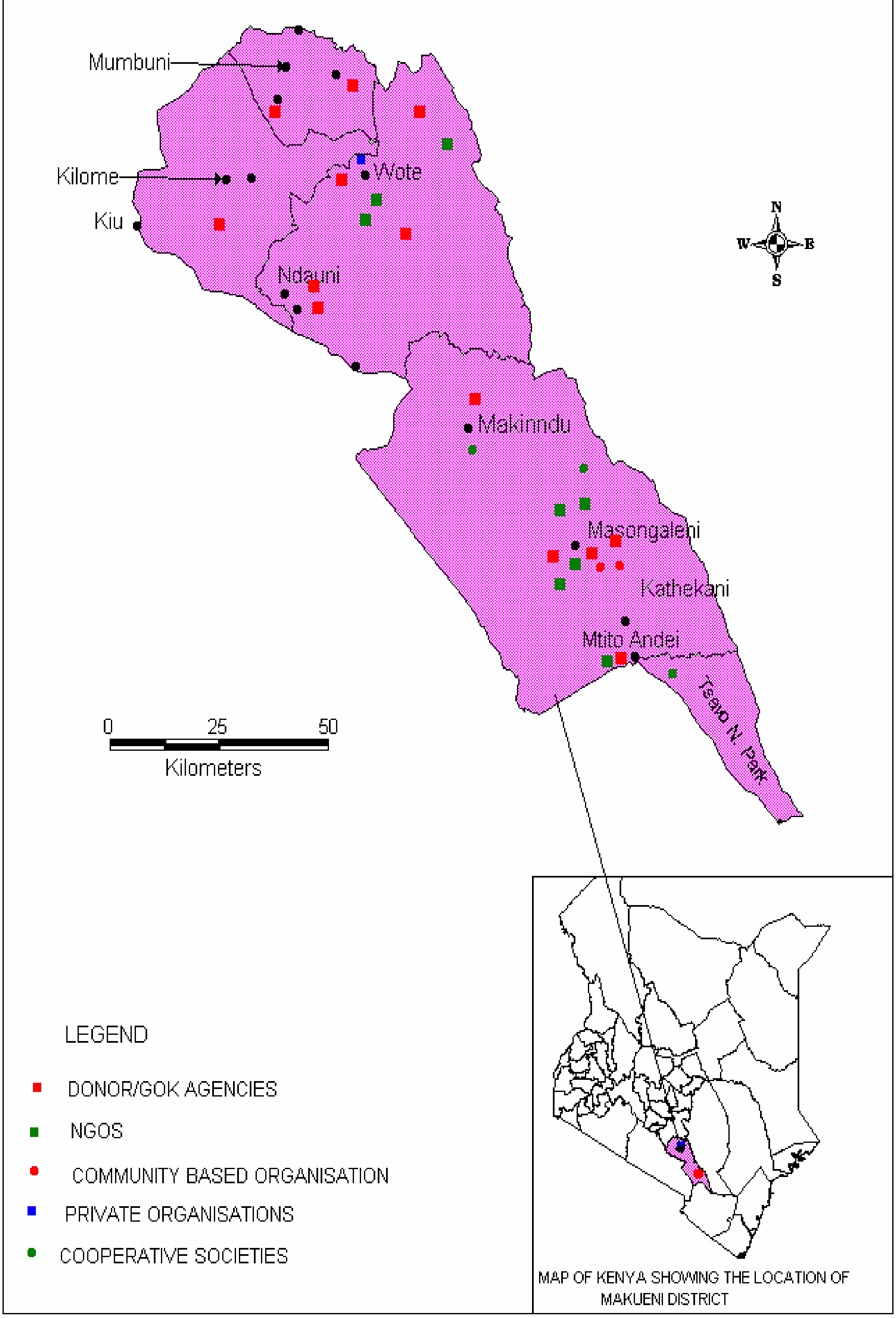
Several organizations have been involved in development programs in the district in the past. These programs have included education, crop and livestock production, livestock health, forestry, water, human health, credit, and infrastructure development. Some of the programs that have targeted livestock production include the following:

- German Agro-Action (GAA), an agricultural project initiated under GTZ in 1995 covering Kibwezi, Makindu, Mtito Andei, and Nguu divisions. Among other objectives, the project focused on livestock production including the promotion of improved production practices, upgrading of livestock, and training of farmers. It was also involved in training CBAHWs for management of livestock health.

- Intermediate Technology Development Group (ITDG) program that focused on training the community on animal health and control of animal diseases and their vectors, among other issues. The program started in 1994 in Mtito Andei division and has been instrumental in training CBAHWs.

- The University of Nairobi and Government of Kenya community-based animal health care project initiated in 1996 in Kibwezi division.

Figure 1. Makueni District



Makueni district was selected because of these programs promoting the concept of CBAHWs in managing animal health.

Because of limited funds, one division (Mtito Andei) was purposively selected for implementation of the study. This is the largest division in the district with the highest concentration of CBAHWs and is easily accessible. The division covers an area of 1,809 square kilometers with a population of about 70,000 people (CBS 2001). Experience has shown that CBAHWs operating in agropastoral areas, like Makueni have similar modes of operation. These CBAHWs attend to their neighbors' animal health problems in addition to their own, whereas CBAHWs found among pastoralists concentrate more on treating their own animals and only sell drugs to other pastoralists (ITDG 2000a). Therefore, it is assumed that the findings of this case study could be applicable to other CBAHWs working within agropastoral communities.

1.4 The conceptual framework

The market for livestock health services responds to the needs of livestock keepers with products that are either tangible (such as drugs and vaccines) or intangible (such as diagnosis). The structure and strengths of each of the suppliers of health services generate complex and often competing behavior, which in turn shapes the dynamics of power relationships within the animal health market. Variations in the types of interventions and responsibilities offered by each health service provider (or channel) shape these relations. The restructuring of the livestock health sector is likely to lead to emergence of new animal health delivery channels. With each emerging or persisting health delivery channel, livestock keepers' expectations, behaviors, and responses to the forms, types, and prices of these health delivery channels determine the pace and success of the restructuring process.

The transition from the old to the new market is of fundamental importance. Livestock keepers' participation in the new market must be assessed, and based on this assessment, any innovations in the market need to be reshaped before a conclusion is drawn with confidence that the veterinary service system is effective and sustainable.

Following the restructuring process, there exist four distinct, yet related animal health delivery channels within Kenya's marginal areas. They include:

- The traditional system of government veterinary professionals and their accompanying paraprofessionals, who exist on a reduced scale owing to decline in government funding;

- The CBAHWs who have been promoted by nongovernmental organizations (NGOs);

- The village veterinary drug shops (popularly known as agrovets) that supply drugs, often with advice, to livestock keepers;

- A limited extent of purely private veterinarians and para-veterinarians; and

- Ethno-veterinary practices undertaken by some community members.

All these veterinary service providers exist today in marginal areas, sometimes in a single geographic area, and interact in a variety of ways with other economic and institutional factors to affect animal health service delivery and livestock productivity (Figure 2). CBAHWs appear to be an innovation in this veterinary market. Although this study assesses the performance of this innovation and how it interacts with other systems to improve livestock health delivery and livestock productivity, it is important to note that positive results will be attained only if the other components in the environment work.

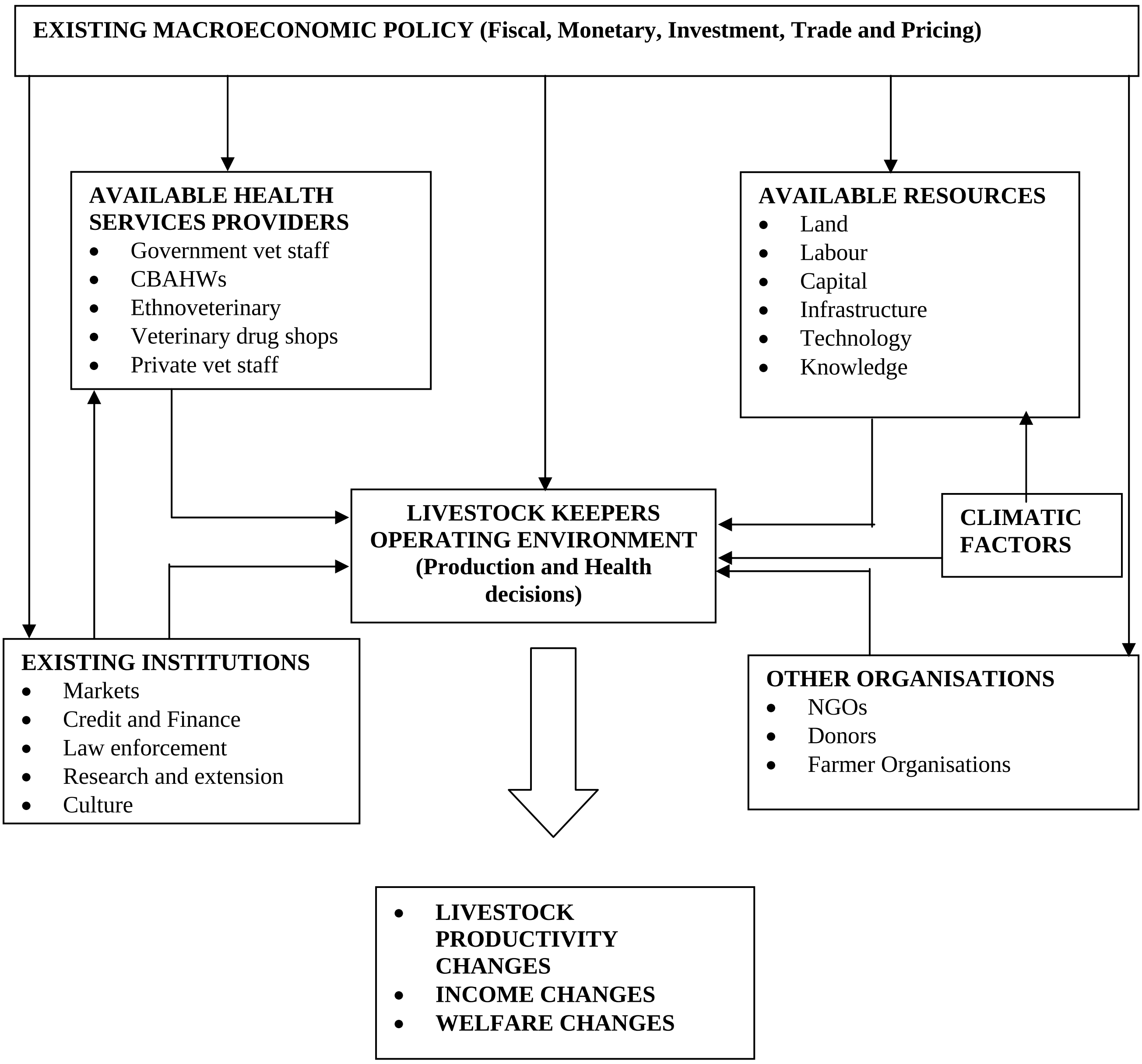


Figure 1 The operating environment of livestock keepers

Source: Adapted from Ly (2000); Omiti *et. al.* (2000)

1.5 Justification of the study

The privatization process and livestock keepers' choice of veterinary services is best understood through the principal/agent framework. Principal/agent theory is a framework that has been expanding rapidly and is devoted to explanations of micro-analytic organizational details. It explains social organizational phenomena using assumptions derived from transaction cost economics. The literature describes it as an analytical tool, joining aspects of law, economics, and organizational theory to observe and understand the organizational variety involved in economic activity (Williamson 1984; Leonard 1993, 2000).

Principal/agent theory can be used to analyze situations in which there is severe imbalance (asymmetry) in information between consumers and suppliers. In the veterinary field, clients (livestock keepers) are at a disadvantage in dealing with the health practitioners (veterinarians and their associated paraprofessionals). The veterinarians are consulted because they have specialized knowledge, but clients cannot be sure that the veterinarians' skills are appropriate to their problem (Ly 2000). Unless this problem is solved, clients lose confidence in the quality of services offered by the practitioners. Clients may reduce their consumption of the services, or they may be prepared to pay no more than the value of the lowest-quality services available in the market, because they fear that this is the service level they are likely to receive. If this information asymmetry is not eliminated, it will lead to what Akerlof referred to as a "market of lemons," a situation in which transaction costs are dominated by inferior products (Akerlof 1970). Possible mechanisms for assuring clients that they are getting high-quality service from their agents are the incentive systems. These include professional supervision, information supply, and strict legislation enforcement that will maximize the agents' effort.

If left alone, the market for veterinary services in Kenya's marginal areas may evolve toward a situation similar to Akerlof's market of lemons, in which clients demand low-quality services. This situation is likely to produce suboptimal results for livestock keepers, animal health practitioners, and the society at large. With several players in the ASAL veterinary market, a quantitative assessment of the efficiency of comparative service delivery, level of outreach, and benefits to livestock keepers of each of these service systems is essential. This study explains how the livestock keepers respond to the particular veterinary service system they face and how well that system responds to their demands and expectations. This is important since the veterinary services market is quite prone to distortions and inelasticities as much as opportunistic behavior of participants is concerned (Ly 2000). It is hoped that this information will guide policy debate regarding veterinary service delivery in the marginal areas.

1.6 Organization of the study

The remainder of this study is organized as follows. Chapter 2 gives a brief account of the evolution, structure, and constraints facing CBAHW programs. Chapter 3 contains details on the methodologies employed in data collection and analysis. Chapter 4 assesses the performance of CBAHW programs in the delivery of animal health services. It also examines the criteria for selection of trainees for these programs and the correlation of these selection criteria to the success rate of the trainees. Chapter 5 describes the clientele of CBAHWs and compares the productivity of livestock served by CBAHWs with that served by other professional services. Chapter 6 assesses the priorities of livestock keepers and the investment opportunities available to strengthen CBAHW programs. This chapter also reviews existing government policy regarding the role of CBAHWs in animal health delivery. Finally, Chapter 7 offers suggestions for changes in policy to improve animal health delivery in arid lands of Kenya in particular and in comparable situations in other developing countries in general.

2.0 THE EVOLUTION OF COMMUNITY-BASED ANIMAL HEALTH WORKERS

2.1 The changing structure of animal health service delivery

Beginning in the early 1980s the Government of Kenya instituted several economic and institutional reforms aimed at improving economic performance and microeconomic stability. In general, the reforms sought to reduce government support and its direct participation in various sectors of the economy. Such measures included price deregulation, trade liberalization, withdrawal of subsidies, and nonparticipation in input and services provision, among others. The government expected these reforms to permit the forces of supply and demand to determine the production, distribution, and marketing of various goods and services in the economy and in essence to promote efficiency and economic growth.

The government's reduced participation in the provision of veterinary services, however, gained momentum in the early 1990s. Until then, the government had been the main provider of animal health services, either free of charge or at a highly subsidized level (Leonard 2000). Major success had been achieved in the control of epizootic and transboundary animal diseases such as rinderpest and contagious bovine pleuro-pneomonia (CBPP). With the growth of the livestock sector, the range and volume of veterinary services to be provided increased tremendously. Consequently, a full range of heavily subsidized services was to be made available to livestock producers ranging from clinical services, extension services, artificial insemination (AI), disease surveillance, and vector control to the production and distribution of drugs and vaccines.

By the mid-1980s various structural reforms were being implemented in the public sector. Consequently, budgetary allocations were reduced to most public sector activities, and animal health service delivery was no exception (Umali, Feder, and De Haan 1994). As budgets failed to keep pace with costs, the government found it easier to make cuts in the operating expenses than in the number of service providers (Anteneh 1984). In some areas, therefore, state-provided veterinary services effectively ceased to exist, and in most areas they fell below the level needed and expected by producers.

In response the state engaged in interesting and commendable experimentation with the aim of finding new models for animal health delivery that would be adapted to the prevailing financial reality. These innovative approaches, which principally entailed privatization, were undertaken after considerable prodding from donors, mainly the World Bank and European Union (De Haan and Bekure 1991). With the broad-based market reforms and the scaling down of government expenditures, the private sector was expected to play a greater role in this field (Otieno-Oruko, Upton, and Mcleod 2000). This privatization, which reflected the neoliberal thinking of the 1980s, was considered more or less a panacea for redressing government failure in providing animal health services. It was argued that the private sector would outperform the public sector even under imperfect market conditions (Bos 1991). Besides efficiency considerations, input delivery through the private sector was considered more sustainable (Leonard 1993; Umali, Feder, and De Haan 1994). Against this background, the privatization of activities hitherto regarded as the domain of the public sector gained credibility.

Privatization broadly entails transferring ownership of resources and responsibilities for provision of services from the public to the private sector (James and Upton 1995). The perfectly competitive market structures that are required for privatization to work, however, are rarely obtainable in the real world (Otieno-Oruko, Upton, and Mcleod 2000). In addition, given Sub-Saharan Africa's thinly spread markets with dispersed producers (or service providers), weak institutions for contract enforcement, and underdeveloped infrastructure, questions remain regarding the performance of the private sector in service delivery. Therefore, the veterinary service privatization program has had varied impact in Kenya depending on range of circumstances.

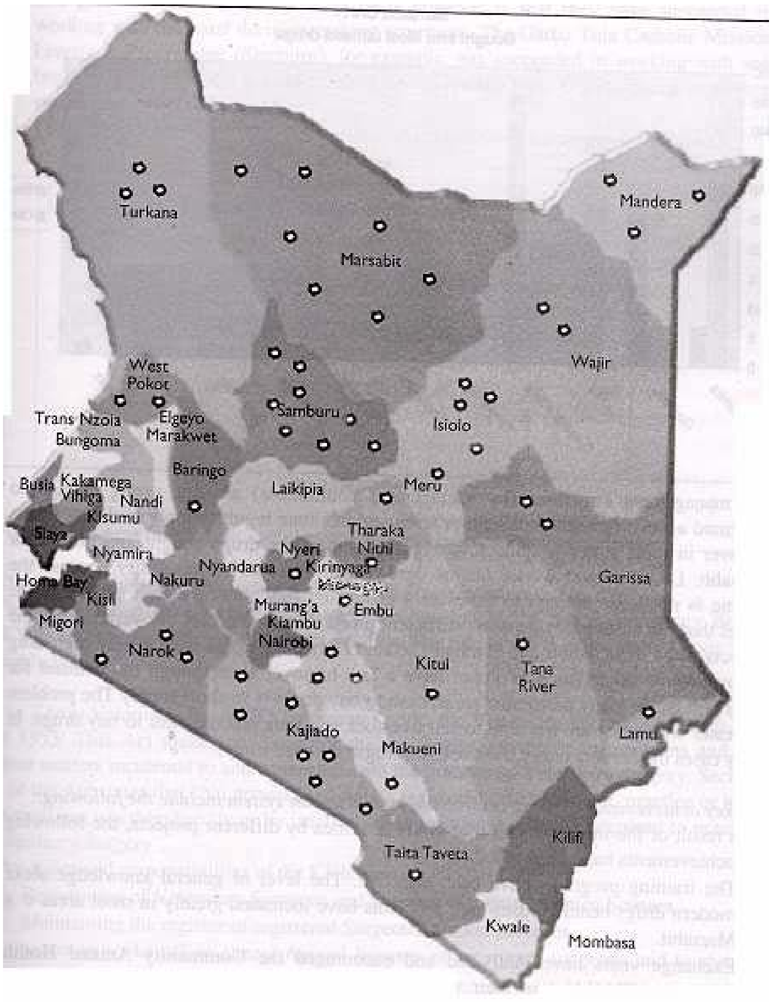
2.2 The evolution of community-based animal health workers in Kenya

The effect of economic restructuring on animal health service delivery has been largely dictated by a location's production system, which in turn depends on the existing agroclimatic conditions. Livestock producers in Kenya inhabit areas with diverse agroclimatic and socioeconomic conditions. Dairying activities have traditionally been concentrated on large-scale ranches in the high-potential areas of the country, but they are now spreading to areas hitherto considered unsuitable for dairy production.

Producers in the high- and medium-potential areas keep crossbred and purebred animals, and herd health has increasingly been handled by private practitioners following the restructuring process. Even in cases where government services are available, they are provided at a fee. In these areas, therefore, both beneficiaries and service providers well understand the concept of privatized animal health (Otieno-Oruko, Upton, and Mcleod 2000).

In the arid and semi-arid lands (ASAL), however, which make up to 71 percent of Kenya's total land mass (Mbogoh and Mukhebi 1998) and hold about 70 percent of Kenya's livestock, herd management has mostly been in the hands of livestock owners and the public sector (Leonard 1987). Farmers keep predominantly indigenous breeds of animals under either pastoral or agropastoral production systems. These areas are characterized by poor infrastructure, harsh climate, low household incomes, and low literacy levels. Qualified veterinary personnel have not set up private practices here, given the cost of establishment and the low demand for these services (Umali, Feder, and De Haan 1994). To meet the needs of livestock owners in ASAL, various groups, particularly NGOs and farmer associations, have initiated community-based animal health delivery systems targeting specific project areas. More than 40 such projects have been initiated in Kenya's marginal areas (Figure 3). These community-based initiatives have tended to be decentralized and privatized animal health delivery services using local traditional knowledge (Leyland and Akabwai 1998). The common feature of these initiatives has been the involvement of local people in identifying key problems, selection of local people for training as CBAHWs, and support of these workers through schemes such as surcharges on veterinary medicines and establishment of a system of drug supply that could easily be accessed (Catley 1999). These CBAHWs are informally trained but complement official professional services.

Figure 3: Location of CBAHWs projects initiated in Kenya



Available literature suggests that CBAHWs have continued to provide animal health services in ASAL (Catley, McCauley, and Delaney 1998; Catley 1999; Akabwai, Shean, and Irungu 2000). The CBAHWs are therefore regarded as one approach that can be used in providing animal health services in the vast and remote areas that are not conducive for private practitioners. These studies, though informal, suggest that CBAHWs are evolving to fill the gap of basic animal health service delivery in most ASAL. These studies have mainly been conducted by NGOs and have used qualitative data. However, policymakers have not quickly recognized or used the information arising from most NGO projects (Catley 1999). They need research-based information that can guide policy regarding the CBAHW model.

2.3 Constraints on the development of the CBAHW model

One constraint to using CBAHWs as a model of animal health service delivery in marginal areas of Kenya is that this approach has not fit within the existing legal and policy framework for animal health. CBAHWs are prohibited by law from administering veterinary drugs or keeping these drugs for purposes of trade. The evolution of CBAHWs has been in contravention of existing policy guidelines on veterinary service delivery systems in Kenya. Available literature emphasizes the need for a clear legal framework setting out the relationship between CBAHWs, veterinarians, and the other animal health practitioners. Lack of defined roles for CBAHWs within the policy framework is a key factor in professional veterinarians' reservations about CBAHWs in Kenya in particular and in other developing countries in general. These technicalities, compounded by the lack of scientific evidence that CBAHW programs are effective, has led to active resistance to CBAHW programs.

The viability and effectiveness of CBAHW programs is dependent upon communication, support, and cooperation with the professional veterinary system (De Haan and Bekure 1991). These professional systems consist of:

- Professional veterinarians consisting mainly of degree holders; and
- Two cadres of para-veterinarians (or paraprofessionals) who include diploma holders trained in animal health and certificate-level paraprofessionals trained at the animal health training institutes (AHITI).

If CBAHWs are to provide livestock health services efficiently, they need to be an integral part of these services (Oakeley 2001). The appropriate roles of CBAHWs must be recognized by law and incorporated into the regulations governing animal health services. However, poor cooperation between CBAHWs and these traditional veterinary service providers has commonly left CBAHW programs reliant on structures set by the infrastructure of nongovernmental that established them (Sikana et al. 1992). Since one of the cornerstones of these programs is the referral of more complex cases and notifiable diseases to the professional veterinary system, the reporting of such cases has been patchy and ineffective because the professional system has low regard for CBAHW system. Oakeley (2001) reports that CBAHWs in Ghana carry an annually renewable license, which helps clarify the roles of these workers to all stakeholders, including other veterinarians and farmers.

In Kenya the legal status of CBAHWs is particularly important with regard to the sale and use of veterinary drugs. Drug sales to livestock keepers are an important source of income, and restrictive drug controls constrain the role that CBAHWs are able to play (De Haan and Bekure 1991). If livestock keepers must go to veterinary drug shops for medicines, they are unlikely to seek the advice of CBAHWs who cannot provide the drugs they prescribe. The argument against liberalization of drug regulations is that it will risk the misuse of these drugs by poorly trained operators and farmers. This risk could be minimized by careful training and supervision of CBAHWs. Moreover, the existence of unofficial markets for veterinary drugs undercuts this argument against liberalization. These unofficial markets enable livestock keepers to buy and administer drugs unsupervised. The potential misuse of drugs obtained from unofficial markets could be minimized through the enhanced activities and accessibility of adequately trained CBAHWs.

Oakeley (2001) argues that while the literature discusses how to engender community participation, it offers few insights into facilitating their institutional participation. Available literature reveals that key stakeholders such as field veterinary staff are not adequately involved in the planning and operation of some CBAHW projects (Sikana et al. 1992).

NGOs have set up many projects to fund and support the early stages of implementation. Consequently, government services are not involved and thus feel no control or ownership when attempts are made to institutionalize the CBAHW model. Further complication arises from the fact that there exists little information as to whether these programs are effective and impact positively on animal health service delivery. The dependence of these programs on external support leads to serious questioning of their sustainability.

3.0 IMPLEMENTATION OF THE STUDY

3.1 Data collection methods

Both primary and secondary data were collected from farmers and other stakeholders in the livestock industry in Makueni district. We collected these data via literature review, reconnaissance visits, and formal surveys.

3.1.1 Literature review

Review of official and research documents was the main source of secondary data. These were collected from official documents from the various ministries, policy documents from the veterinary department and Central Bureau of Statistics (CBS), and other relevant sources. District development plans and articles from various organizations including NGOs that have been involved in implementing CBAHW programs were also reviewed. The literature review allowed us to obtain a general picture of the environment, to understand the socioeconomic setting of study area, and to make a preliminary mapping of this area. At the same time, the review was undertaken to illuminate the nature and evolution of the participants in the animal health service market in the study area.

3.1.2 Reconnaissance visits

We made reconnaissance visits to introduce ourselves to various stakeholders, to inform them of the aims of the study, and to make appointments for either discussion or document access, retrieval, and perusal. These visits also involved the following:

- *Consultations with key stakeholders:* These consultations were undertaken to assess what stakeholders think about CBAHW programs in their places of jurisdiction and how these programs should be strengthened. Consultations (interviews) were undertaken with key stakeholders from government departments, local communities, and district-based NGOs.

- *Individual farmer interviews*: We held informal discussions with some selected farmers focusing on the various sources of animal health services, their availability, reliability, cost, and effectiveness. The aim was to assess farmers' opinion on the quality of information disseminated by CBAHWs.

- *Interviews with implementers of CBAHW programs*: These interviews focused on the training package of the CBAHW. This step involved examining the training manuals for the CBAHW programs and observing the caliber of the training personnel.

- *Interviews with veterinary officers and paraprofessionals:* These interviews included information on the views of veterinary officers and paraprofessionals regarding CBAHWs, what they think CBAHWs should do, what they should not do, and how this program could be improved. The aim was to highlight points of conflict between CBAHWs and veterinary staff and areas of investment for improved performance of the CBAHW programs.

3.1.3 Formal surveys

The information gathered by informal methods was evaluated and quantified in the formal surveys. Two comprehensive questionnaires were drawn up and pretested. *The first was a* questionnaire targeting all CBAHWs resident in the study area. In total, 35 respondents were interviewed. This questionnaire had major sections on: (1) the personal characteristics of CBAHWs, (2) the training, activities, and constraints faced by CBAHWs, and (3) the relations between CBAHWs and livestock keepers and between CBAHWs and highly trained paraprofessionals and veterinarians. The questionnaire was pretested on five CBAHWs and amended before it was applied in this study. Interviews lasted about 45 minutes, it took five days to complete the 35 CBAHWs (June 2001). A team of six enumerators and one research assistant supervised by one of the researchers conducted the interviews.

The second questionnaire targeted livestock keepers. Data were collected from a randomly selected sample of 182 farmers using a comprehensive questionnaire that had been pretested and amended. The questionnaire sought information on various aspects including:

- Information on the livestock keepers' approaches to the management of animal health;
- Knowledge of CBAHW programs as well as other animal health service (AHS) delivery systems in the area;
- The household head's opinion on the type of services provided by the CBAHWs, their reliability and benefits, and how the services could be improved; and
- Information on herd dynamics including mortality, morbidity, births, receipts, and sales between 1998 and 2000.

Interviews took about one hour, and completing 182 visits took three months (June to August 2001). Like the CBAHWs' questionnaire survey, a team of six enumerators and one research assistant supervised by one of the researchers conducted the interviews.

3.2 Sampling methods

Sampling was done in two stages—that is, for CBAHWs and for livestock keepers. Total sampling was done for the resident CBAHWs. To select respondents for the livestock keepers interviews, a sampling frame for the whole district was obtained from the Central

Bureau of Statistics based on the 1999 population census (CBS 2001). Based on these figures, Mtito Andei division had a population of 66,663 people in 13,354 households. These households were clustered in 228 villages. Twelve villages were randomly selected. From these villages 180 households were then randomly sampled, with probability proportional to population size of village. The selected households were visited, and the household head interviewed.

3.3 Data analysis

Descriptive statistics were used to describe the characteristics and activities of CBAHWs and the farm and personal characteristics of the livestock keepers. The relationship between the characteristics of the CBAHWs and their level of success was established using correlation and regression analysis.

In assessing the success of the CBAHWs, the study tracked their performance through activity analysis and used level of activity as a performance measure. Generally in such estimations, relations are often modeled simply as structural relations between the traditional factors perceived to be influencing activity levels and the variables representing output. Once a decision about candidate variables is made, the specific relationship can then be modeled. The quadratic model was selected in this case because of its computational ease, ease of interpretation, interpolative and extrapolative robustness, and consistency with data.

The estimated model was of the form:

$$\mathbf{X = [ß][Z],} \qquad \mathbf{(1)}$$

where

X is the level of activity of CBAHWs, estimated as the number of cases handled in the one-year period preceding the survey;

ß is a vector of estimated coefficients; and

Z is a vector of independent variables describing the characteristics of CBAHWs.
An ordinary least squares stepwise regression approach was used in estimation of the model.

Factors that are likely to keep CBAHWs in active practice were identified using a logistic regression. The dependent variable in this case was observed as a binary indicator—that is, whether or not a CBAHW is still providing services. Although it is possible to use dummy variables as dependent variables to see such a dichotomous choice, ordinary least squares regression is not appropriate in such circumstances for several econometric reasons. Nonlinear estimation techniques have been developed to overcome some of the major statistical problems. Two techniques most commonly used in this instance are probit and logit analyses. The probit uses the cumulative normal function whereas the logistic function uses the logit model. Although both use the maximum likelihood estimation method, the logistic function[5] was thought to capture the distribution of the data better and thus used in this study (Maddala 1983; Greene 1993).

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[5] Some of the outputs of the logistic procedure and their interpretation are given in the Appendix.

The estimated model was of the form:

$$I = \beta Z, \qquad (2)$$

where
I = 1 if CBAHW is active, otherwise zero;

Z is the vector of exogenous variables (those describing CBAHW characteristics); and

ß is a vector of estimated coefficients.

The method of backward-stepwise variable selection was used to identify significant determinants of the likelihood of a CBAHW's remaining active.

Analysis of variance (ANOVA) was used to investigate differences in productivity between livestock keepers using different animal health delivery systems. This productivity analysis was based on the premise that improved animal management, including regular deworming and disease prevention, may increase productivity of both cattle and goats (CARD 1989). The animal health service in use could improve animal production by enhancing both the levels of health and the production management standards. The impact of animal health services can be analyzed by relating the size and productivity of herds to the type of service used. The degree of success that livestock keepers have achieved under each delivery channel in increasing livestock fertility and decreasing calf mortality can be obtained by calculating a breeding index (BI). The BI compares the percentage of young animals in a farmer's herd with the percentage of adult females.

$$BI = \frac{\%\,YA}{\%\,AF}, \qquad (3)$$

where
BI = breeding index;
YA = young animals; and
AF = adult females.

Woods (2000) used this approach to estimate the productivity of goats in relation to distance from the source of animal health services in Zimbabwe. This study adopted Woods's approach to estimate and compare the productivity of cattle and goats under the different health delivery channels. In addition, this study also estimated the ratio of live births to the number of adult females in the herd in each year between 1998 and 2001.[6] This was named the birth ratio (BR).

[6] Initially during the design of the study, milk output had been targeted as the indicator of herd productivity and a switching regression model as a tool to assess differences in productivity between users and nonusers of CBAHW services. It became clear as the study progressed that milk was not the main objective of livestock keepers in the study area. Only 3.8 percent of the livestock keepers regarded milk as an important product of their livestock enterprise. Most livestock keepers did "partial" milking, leaving some for suckling calves. The data obtained for milk production did not therefore reflect the actual output. Furthermore, using milk as the productivity parameter would have excluded goat keeping that was undertaken by 97 percent of livestock keepers, compared with 77 percent for cattle.

$$BR = \frac{LB}{AF}, \qquad (4)$$

where
BR = birth ratio;
LB = number of live births; and
AF = number of adult females.

The BR and BI were compared for livestock keepers using different animal health delivery channels.

4.0 FEATURES OF COMMUNITY-BASED ANIMAL HEALTH WORKERS

4.1 Characteristics of the CBAHWs

The criteria for choosing CBAHWs vary, but there is general agreement on the need for community choice and control over candidate selection. Many programs offer basic guidelines for selecting appropriate candidates based on personal characteristics. Although personal characteristics are hard to define and measure, they are critical, since sustained support and respect within a community depends on them. In traditional societies individuals occupy specific positions, and the roles they play are determined in advance by their social positions. Consequently, the discharge of such functions and roles does not generate differentiated existence but simply confirms it. For this reason, individuals perform specific tasks in accordance with an *a priori* rule defining their social identity (Platteau 1994). With respect to CBAHWs, some of the personal characteristics that could determine social position include literacy, gender, age, and experience of stock raising (Holden 1997; Leyland and Akwabai 1998; Oakeley 2000).

Literacy is seen as a prerequisite for learning, recording, and drug handling activities and therefore forms an important ingredient of a CBAHW candidate. One school of thought, however, speculates that a higher level of education is associated with higher income and career expectations among the trainees, and these expectations could make them more likely to emigrate from the area. The net effect of literacy on the success rate of an individual as a CBAHW will therefore be determined by the relative strengths of these two opposing forces and is therefore indeterminate.

Experience in stock raising, measured as years of stock-keeping experience, appears to be an obvious criterion and may go together with livestock ownership. There is, however, no evidence that limited experience with livestock would preclude an individual from becoming a successful CBAHW. It is therefore reasonable to anticipate that trainees' stock-raising experience will have a positive impact on their likelihood of becoming successful CBAHWs.

Opinions differ regarding the appropriate age of trainees, although health and fitness requirements may exclude some older candidates. Older candidates, however, may enjoy greater respect and trust within the community and may be less likely to move away. Currently, there is no evidence in the literature to suggest that younger candidates cannot perform equally well. The net effect of age on the likelihood of success as a CBAHW is therefore indeterminate.

Gender remains a sensitive issue. Programs implemented in many regions have shown a male bias in the selection of trainees. There is little discussion about why this should be the case, despite the fact that many programs actively discuss the important role of women in raising livestock and thus their potential as CBAHW candidates. Therefore it would be difficult to determine the effect of gender on the likelihood of one's becoming a successful CBAHW.

To capture the varying levels of literacy among these workers, the research team recorded the highest level of education completed. They found that 74.3 percent of the workers had a primary level education, 22.9 percent had attained a secondary level education, while the remainder had attended adult literacy schooling. All the workers could read and write. Years of farming experience ranged from 4 to 40, with a mean of 18.2 years and a standard deviation of 1.71. Years of experience depended mainly on the age of the workers. The mean age was 50.7 years with a standard deviation of 10.6. As for gender, out of the 35 sampled CBAHWs, only 7 were females, confirming the gender bias toward male candidates as reported in the literature.

Besides gender, education level, years of farming experience, and age, researchers also collected information on the number of refresher courses undertaken, possession of business skills, and total income of these workers. Information on refresher training was collected because available literature indicates that refresher courses provide a forum for the continued professional development of these workers (Holden 1999). To remain in business, these workers need to remain more knowledgeable than ordinary farmers on animal health matters. Given the limited initial training offered to these workers, it could only be a matter of time before livestock keepers in the surrounding area acquired equivalent animal health knowledge and—having done so—then dispense with their services. The level of professional development should have a positive effect on likelihood of success as a CBAHW. Thirty-two of these workers had attended refresher training, ranging from one to nine times.

It can be argued further that for CBAHWs to continue to provide services, they must be able to price their products competitively so as to run their services profitably. In order to remain financially viable and become successful workers, CBAHWs must possess business skills, possession of these skills is postulated to have a positive effect on success. To capture this factor, researchers asked the workers whether they had undertaken any training in business skills. The results showed that 45.7 percent of the workers had undertaken such training.

Other factors that may impede success for some trainees could be lack of credit and the difficulty of receiving prompt payment for their services (Holden 1997). This study assumed that under such circumstances, these workers may rely on their own capital as a stopgap measure to finance their activities. Own income could therefore have a positive effect on level of success. Consequently, the total income of each CBAHW from farm and nonfarm activities was recorded. This income ranged from Kshs 2,000 to 217,200 per year and did not show significant variation between villages, gender, or possession or lack of business skills ($p < 0.05$). The effect of these hypothetical micro-level institutions on the likelihood of trainees' becoming successful CBAHWs is summarized in Table 1.

Table 1 -- Hypothetical impacts of personal characteristics on level of activity of CBAHWs

Variable	*Direction of impacts*
Gender	±
Age	±
Education level	±
Years of farming experience	+
Number of refresher courses	+
Possession of business skills	+
Total income	+

4.2 Activities of CBAHWs

CBAHWs provide a localized service consisting mainly of clinical services. The survey results indicate that 60 percent of these workers keep records of their activities. These records include disease cases handled, drugs used, and the prices of the drugs. These workers handle diseases and ailments in cattle, sheep, goats, and poultry. Table 2 summarizes some of the diseases and ailments that were handled by these workers in the one-year period preceding the survey.

Table 2 -- Types of diseases and ailments handled by CBAHWs in the one-year period preceding the survey

Livestock category	Disease or ailment	% of CBAHWs who report handling this disease or ailment
Cattle	Tick-borne diseases	69
	Trypanosomiasis	60
	GIT parasites	51
	Coughing	43
	Wounds	31
	Severe diarrhea	28
	Foot rot	17
Sheep	GIT parasites	49
	Coughing	31
	Foot rot	14
Goats	GIT parasites	57
	Coughing	40
	Severe diarrhea	26
	Foot rot	26
	Wounds	14
	Difficulty in kidding	11
	Eye infection	6
	Pneumonia	6
Poultry	GIT parasites	17
	Coccidiosis (bloody diarrhea)	6
	New Castle (greenish diarrhea)	6

Source: Survey data, 2001.

Note: GIT = gastrointestinal.

The most common ailments and diseases handled by CBAHWs were gastrointestinal parasites in all stock types, trypanosomiasis and tick-borne diseases in cattle, and coughing in small stock. Information was sought on the type of the last case handled by each worker (Table 3). Ninety-one percent of these workers reported that they attended to the last case after being called by the owner of the animal, while the rest indicated that they had come across it during their routine visits to farmers. Eighty-six percent of the workers had attended to their last case within a period of one year preceding the survey. Those who had not attended to any case for a period exceeding one year had ceased practicing, citing either lack of interest by livestock keepers in their services or their own interest engaging in other activities.

Table 3 -- Type of last case handled by CBAHWs

Disease or ailment	% of CBAHWs reporting this as last case they handled
Tick-borne diseases	37
Trypanosomiasis	37
GIT parasites	20
Coughing	6

Source: Survey data, 2001.

A summary of the mean number of cases handled by CBAHWs for each livestock type for a period of one year prior to the survey was recorded (Table 4).

Table 4 -- Mean number of cases handled by CBAHWs for a period of one year prior to the survey for different types of livestock[7]

Livestock type	Mean number of cases	Std. deviation
Cattle	26.7	43.43
Goats	35.8	47.55
Sheep	13.8	36.55
Poultry	16.3	30.01

Source: Survey data, 2001.

These workers handled about 2,963 cases during this period, giving a mean of 92.6 cases per worker per year. The number of cases handled by each worker varied widely. The reason for this could lie within individual-level attributes. Factors that are common to all CBAHWs, such as cultural attitudes, the prevailing demand for animal health services, and regulations could not be causes since they affect all CBAHWs across the board.

Available literature suggests that the effectiveness of a CBAHW program depends upon support and cooperation with the professional veterinary system (De Haan and Bekure 1991).

[7] Data from three workers were found insufficient and were not used in the analysis.

It is argued that these workers need to be an integral part of the veterinary delivery system by acting as a link between farmers and veterinary staff. The level of contact between these two pathways, however, will be dictated by several factors, some of which include the working rapport, the distance between them, and the professional challenges encountered by the less-qualified group (CBAHWs) in their day-to-day activities. If the CBAHWs handle less-challenging tasks, then there is bound to be less contact. Seventy-one percent of these workers reported that they had made one or more referrals to professionally trained animal health workers during the period they had been practicing. Total cases referred for each livestock type for all the workers is given in Table 5. A total of 83 referrals had been made since the inception of the program, giving an average of 6.4 cases per year. It is difficult to judge the effectiveness of the program on the basis of the number of referrals, unless the nature of cases handled is also evaluated. Nonetheless, this study establishes that there is some level of professional exchange between the two channels of animal health delivery.

Table 5 -- Total number of cases per livestock type referred to professionals by CBAHWs since inception of the program

Livestock type	**Total number of cases referred**
Cattle	52
Poultry	19
Sheep	7
Goats	5

Source: Survey data, 2001.

CBAHWs were on average 33.5 kilometers from the nearest trained veterinary personnel and 13.5 kilometers from the nearest veterinary drug shop (Table 6). It would be better to establish whether these two channels complement or constrain the activities of CBAHWs. Trained veterinary personnel could either be an avenue for CBAHWs to enhance their professional capability, or they could be an alternative source of animal health services. The same applies to veterinary drug shops, which could act as accessible sources of drugs to enhance the activities of CBAHWs, or they could be an alternative channel of health services delivery to livestock keepers. These issues are addressed in the next section.

Table 6 -- Accessibility of CBAHWs to personnel and facilities that could influence their work

Personnel or facility	**Mean distance (km)**	**Standard deviation**	**Minimum distance (km)**	**Maximum distance (km)**
Town	12.10	10.33	1	40
Veterinary officer	33.50	22.30	1	65
Para-veterinarian	21.20	13.61	2	60
Road open all year round	12.82	15.81	0	62
Seasonal road	7.94	12.17	0	40
Market	8.10	8.02	0	32
Veterinary drug shop	13.50	10.73	1	40

Source: Survey data, 2001.

4.3 Factors influencing the level of activity of CBAHWs

On the assumption that the criteria for selecting trainees is crucial to their success as CBAHWs, the research team undertook a further analysis to identify the relationship between trainee personal characteristics (in Table 1) and their level of activity as CBAHWsCurrently, there is limited understanding of the interaction between selection and success. Until success is clearly defined, the role of selection and the criteria employed cannot be adequately assessed. As a starting point, the assessment of CBAHWs' success should incorporate their level of activity, technical competence, role and coverage within the community, commitment to work, motivation, and sustainability (Oakeley 2001). This study took the level of activity to be an indicator of success. The level of activity was measured as the number of cases handled by a CBAHW in a given period, which in this case was the one-year period preceding the survey. The correlation between the level of activity and personal characteristics revealed that the number of refresher courses undertaken, which is an indicator of professional development, had a significant and positive relationship with the level of activity of CBAHWs (Table 7). No other variables appear to significantly correlate with the level of activity of CBAHWs.

Table 7 -- The relationship between level of activity and characteristics of CBAHWs

Variable	Correlation coefficient	Significance level
Refresher courses attended	0.6244	0.000
Distance to open road	0.3692	0.038
Distance to town	0.3287	0.066
Distance to a veterinarian	0.3228	0.072
Distance to drug shop	0.3118	0.082
Total nonfarm income	-0.2646	0.143

Source: Survey data, 2001.

Analysis was also undertaken to establish if there were differences in level of activity based on gender and possession or lack of business skills. There were no significant differences in the number of cases handled between male and female workers ($p = 0.05$). Business skills were assessed at two levels: first by training and second by management or commitment to work as a CBAHW. Training entailed courses undertaken in business skills, and management encompassed proper day-to-day running of health care practice by keeping records. Intuitively, one would guess that those who had undergone training in business skills were more likely to keep records and thus that the two variables were likely to be correlated. This was not the case, however, for this set of data. There were significant differences in the number of cases handled by workers who kept records and those who maintained no records ($p = 0.05$) (Table 8). Significant differences also existed in the number of cases handled by those workers trained in business skills and those without training ($p = 0.05$). Therefore, it appears that CBAHWs with training in business skills are more active than those without, and gender had no significant influence on level of activity of these workers.

Table 8 -- Differences in level of activity of CBAHWs based on commitment to work and possession of business skills

Variable	Sample size	Mean cases	T-value	P-value
Business skills				
Trained	16	134.62	2.01	0.05
Not trained	16	50.56		
Commitment to work				
Keeps records			4.00	0.00
Keeps no records	18	156.00		
	14	11.07		

Source: Survey data, 2001.

4.4 Building personal characteristics into performance analysis

A linear regression was fitted to determine the strength of each of these variables on the level of activity of CBAHWs (Equation 1). Independent variables used were distance to veterinary drug shop, total annual income from other activities, gender, and the number of refresher courses attended. Distance to nearest veterinary personnel was not used in the estimation procedure (despite being significant at $p < 0.10$) because of its high correlation to distance to nearest veterinary drug shop. Possession of business skills and keeping of records were entered as dummy variables (one indicates training in business skills and keeping of records; zero indicates none). The results are given in Table 9, which shows model buildup from model 1 to model 3.

Table 9 -- Factors influencing the level of activity of CBAHWs in Mtito Andei

Variable	Model 1		Model 2		Model 3	
	b	**S.d.**	**b**	**S.d.**	**b**	**S.d.**
Constant	-35.4640	76.9665	-48.3666	44.4537	-28.4151	26.6491
Possession of business skills (dummy: skills = 1, no skills = 0)	27.7412	44.0604	13.4627	35.7998	-	-
Years of farming experience	2.1995	2.2668	0.8773	1.7149	-	-
Distance to nearest veterinary shop (km)	0.8248	2.2824	-	-	-	-
Keeps practice records (dummy: keeps records = 1, no records = 0)	95.5141*	55.3631	97.0706***	37.5977	97.8637***	34.7738
Refresher courses (number attended)	20.2964**	10.4363	24.3706***	8.2004	25.1278***	7.7756
Male gender, (dummy: male = 1, female = 0)	-18.5412	57.0640	-	-	-	-
Income (Kshs per year)	-0.00051	0.00096	-	-	-	-
R2	0.5563		0.5272		0.5207	
Adj. R2	0.3950		0.4572		0.4876	
F- value	3.4483		7.5277		15.7541	
D.W. test	1.8866		1.8742		1.8863	

Source: Survey data, 2001.
Note: Level of significance: *** = 0.01; ** = 0.05; * = 0.10.

The number of cases handled by the workers was significantly influenced by the number of refresher courses attended and also by whether the worker keeps records or not. All other hypothesized influencing factors (business skills training, income, gender, and distance to drug shop) were not significant.

These results indicate that the CBAHWs who kept records could handle about 98 cases per year more than those who did not, .other things begin equal. In addition, an extra refresher course undertaken could increase the level of activity by up to 25 more cases per year. These findings show that continual professional development through refresher courses and commitment to work indicated by keeping records are important factors in determining the success of the community-based animal health workers model.

4.5 Factors determining the sustainability of the activities of CBAHWs

A logistic regression was used to analyze the effects of personal characteristics, indicators of income, and competition on the likelihood of a CBAHW's remaining in active practice (equation 2). The independent variables included annual income from other activities, distance to veterinary drug shop, years of farming experience, number of refresher courses attended, possession of business skills as a dummy variable (dummy = 1 if trained in business skills and 0 for none), and maintenance of practice records (dummy = 1 for keeping records and 0 for none). Age of the CBAHW and distance to a trained veterinarian were not included because of their high correlation with years of farming experience and distance to veterinary drug shop respectively. The results are given in Table 10.

Table 10 – Factors determining the likelihood of a CBAHW's remaining in active practice in Mtito Andei

Variable	Model 1	S.d.	Model 2	S.d.	Model 3	S.d.
Constant	-12.9467	7.9998	-10.0410	5.9311	-3.8016	1.6892
Possession of business skills (dummy)	2.1471	2.2494	1.6951	1.9645	-	
Years of farming experience	0.2048	0.1590	0.1766	0.1410	-	
Distance to veterinary shop (km)	0.0638	0.0935	-	-	-	
Keeping of practice records (dummy)	6.6088**	3.0838	6.6141**	2.8875	0.9480***	0.5762
Refresher courses (number attended)	2.4166*	1.4686	1.9216*	1.1122	4.7015**	1.5388
Income (Kshs per year)	0.000017	0.000022	-	-	-	
–2Log likelihood/Goodness of fit	12.395/20.454		12.752/25.592		15.018/25.988	
Chi-squared	30.84 (*p* = 000)		30.48 (*p* = 000)		28.21 (*p* = 000)	

Source: Survey data, 2001.
Note: Level of significance: *** = 0.01; ** = 0.05; * = 0.10.

Model 3 in Table 10 was chosen as describing the data best. The model showed that the number of refresher courses and the keeping of practice records positively and significantly influenced the likelihood of a CBAHW's remaining in active practice. These are the same variables that were found to influence the level of activity. In this study, it was difficult to capture all the hypothesized variables in an econometric model, and further investigations are required in this area.

The odds ratio indicates that after attending refresher training three times, a CBAHW is 17.2 times more likely to remain in active practice than one who has attended only once. Furthermore, a CBAHW keeping records is 110 times (95 percent confidence interval 107.10, 113.12) more likely to remain in active practice than the one who keeps none. Table 11 shows that CBAHWs are more likely to remain active with repeated attendance of refresher courses.

Table 11 -- The odds ratio of a CBAHW's remaining active by attending repeated refresher courses

Number of refresher courses	Odds ratio	95% C.I.
One	2.5805	(1.4511, 3.7098)
Two	6.6592	(5.5298, 7.7886)
Three	17.1844	(16.055, 18.3137)

Source: Survey data, 2001.

Possession of business skills did not significantly influence the probability of a CBAHW's remaining in active practice ($p < 0.05$) even though the CBAHWs who had business skills training attended to more cases than those without (Table 8).

5.0. THE CLIENTELE OF COMMUNITY-BASED ANIMAL HEALTH WORKERS

5.1 Farm and farmer characteristics

Livestock keepers interviewed were on average 49 years of age. They owned an average of 27.8 acres of land (ranging from 2 to 268). All of the households kept some livestock, which included cattle, goats, sheep, and chicken. Table 12 gives the current numbers of livestock kept and estimates of income from various major cropping activities in the previous season.

Table 12 -- Current mean numbers of livestock owned and the estimated income from crop enterprise of the previous season

Enterprise type	% of farmers undertaking the enterprise (n = 182)	Sample mean	Sample std. dev.
Cattle	77	5.960	9.80
Goats	97	27.30	29.75
Sheep	32	3.040	7.59
Maize income (Ksh/year)	97	15499	22777
Cow peas income (Ksh/year)	71	2679	4680
Sorghum income (Ksh/year)	30	836	2539
Millet income (Ksh/year)	10	179	1108

Source: Survey data, 2001.

Sample farmers kept about 5,523 small ruminants (goats and sheep) and 1,085 cattle during the year preceding the survey. This gave a sample average of 30 small ruminants and about 6 cattle per household. More goats were kept than sheep, at a ratio of 9:1. An analysis of the trends in livestock numbers following the privatization of veterinary services in 1991 showed that the proportion of farmers keeping cattle, sheep, and goats slightly increased between 1992 and 2001 (Figure 4), while the total number of livestock fell slightly (Figure 5). This reduction, however, may not be entirely attributable to changes in animal health service delivery.

About half of the household heads interviewed engaged in some form of additional income generation besides crop sales and livestock off-take. These other activities included running small informal enterprises (30 percent) and employment in the government or private sector (20 percent). Furthermore, about 10 percent of spouses of household heads were also engaged in off-farm income generation. The mean annual nonfarm and farm incomes were Kshs 10,464 and Kshs 43,155, respectively. The total farm income, computed as sum of farm and nonfarm income, was not significantly different between male and female headed households ($p < 0.05$). Female-headed households formed 21 percent of the sample. The majority of household heads interviewed had a primary school education (Figure 6), and about 87 percent of the household heads visited were literate.

Figure 2 Trends in percentage of farmers keeping livestock, Mtito Andei division

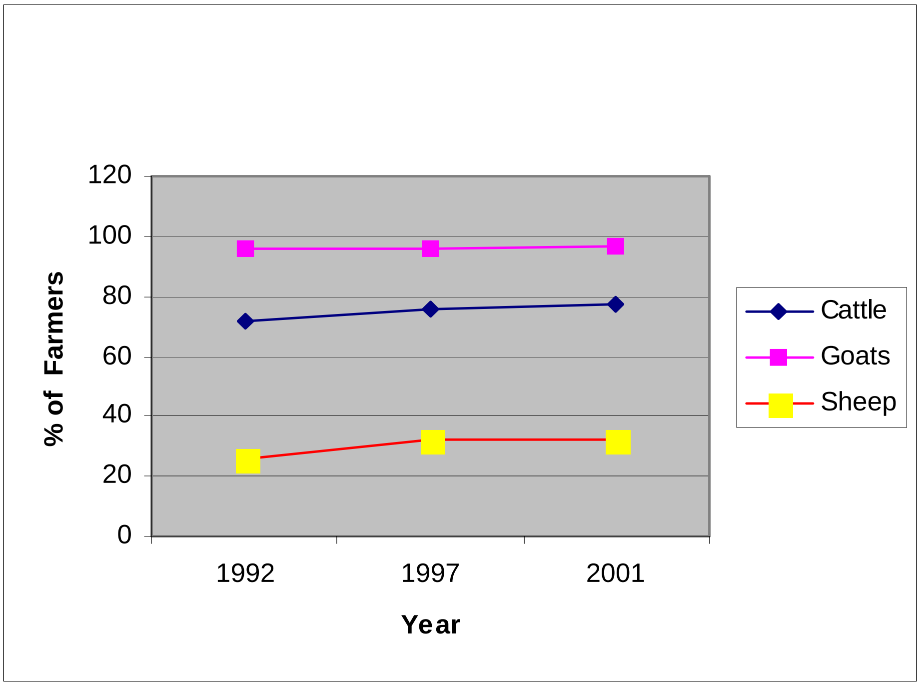
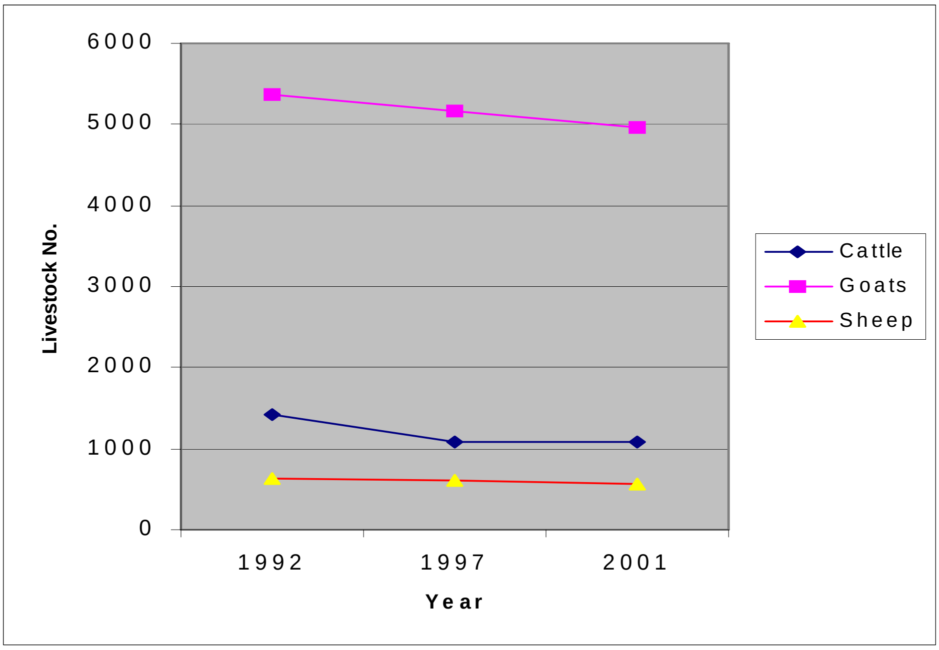
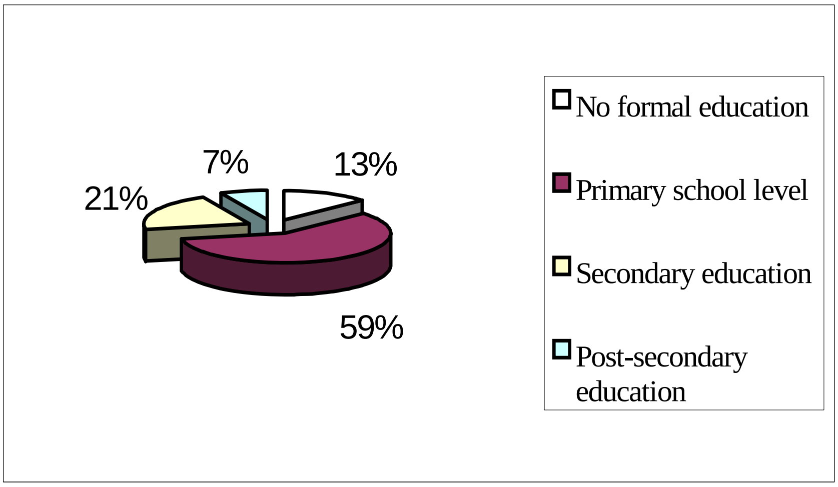


Figure 3 Trends in sample livestock numbers (1992 - 2001), Mtito Andei



Source: Survey data, 2001

Figure 4: Percentage of household heads with varying levels of education



Source: Survey data, 2001

Information was also collected on possession of assets to give an indication of wealth. Assets included housing and means of transport owned such as animal-drawn cart, bicycle, or motorized vehicle (Table 13).

Table 13 -- Percentage of livestock keepers owning different assets

Type of asset	% of farmers owning the asset
Bicycle	90.70
Permanent house (brick/ stone wall and iron sheet roof)	64.30
Animal-drawn cart	13.70
Motorized transport	4.70

Source: Survey data, 2001.

The farmers in the study region rely mostly on bicycle transport owing to a poor road network. The average distance from the farms to a seasonally passable road was 7.6 kilometers (range: 0–58 kilometers, standard deviation = 7.10), whereas the average distance to a road passable all year round was estimated at 13.10 kilometers (range: 0–63 kilometers, standard deviation = 20.90).

5.2 Access to and utilization of animal health services delivery channels

The animal health delivery systems identified in the region included government veterinary services (one veterinarian and one para-veterinarian commonly known as an animal health assistant, or AHA), private veterinary practice undertaken by a para-veterinarian, the veterinary drug shops, and CBAHWs. The mean distances from the livestock keepers' farms to each of these health delivery source points are summarized in Table 14.

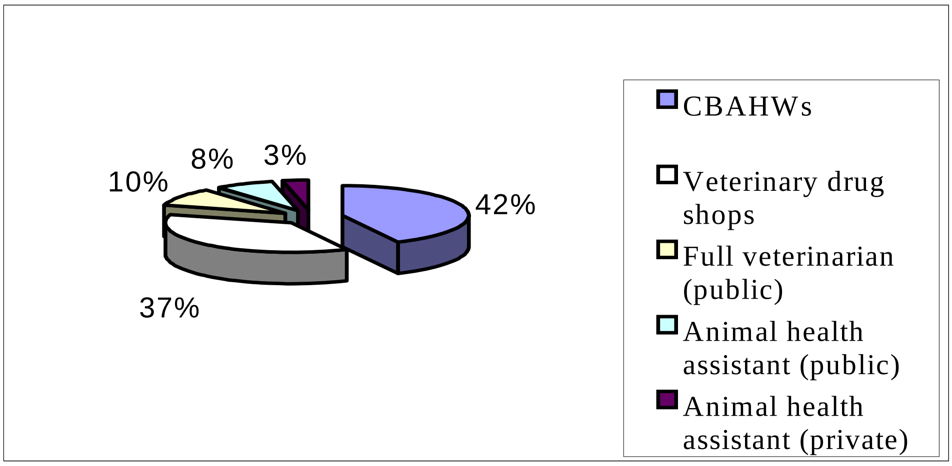
Table 14 -- Mean distances to nearest sources of different animal health delivery services

Type of service	Mean distance (km)	Range	Std. dev.
Veterinarian	33.79	1 – 61	31.88
Animal health assistant	21.91	1 – 64	8.72
Veterinary drug shop	12.46	1–36	9.05
CBAHW	2.00	0–15	1.72

Source: Survey data, 2001.

Information was gathered to determine how livestock keepers used each of these health delivery services during the year preceding the survey. The proportion of livestock keepers who had made contact with each of these health delivery services is shown in Figure 7.

Figure 5: Percentage of livestock keepers that made contact with various animal health delivery systems



CBAHWs were the most utilized channel, whereas private para-veterinarians were the least used. It appeared that the public veterinary staff were acting in their private capacity and charging lower fees than the private practitioners. It was difficult to compare the charges imposed by these health delivery channels, however, because of differences in the nature of the cases they handled. Otieno-Oruko, Upton, and Mcleod (2000) noted that public veterinary personnel could be using government facilities to engage in private practice (popularly known as semi-private practice) and thus constraining the development of private veterinary practice.

Each respondent was asked to give the most preferred health delivery channel based on a number of parameters, particularly cost, effectiveness, availability, and reliability. The findings are summarized in Table 15.

Table 15 -- Ranking of the health delivery channels by livestock keepers

Animal health delivery channel	% of respondents mentioning the channel as the most preferred
CBAHWs	40
Public veterinary services	34
Drug shops	21
Private veterinary services	1
Ethnoveterinary	1

Note: Not all percentages add up to 100 because of nonresponses in some cases.

Source: Survey data, 2001.

Table 15 shows that CBAHWs was the most preferred channel. About 44 percent (n = 171) of the respondents indicated that their most preferred channel was not the most utilized channel. The main reasons given were that the most preferred channel was either not readily available (75 percent, n = 76) or it was expensive (24 percent).

Table 16 gives the main ailments encountered by the livestock keepers and the type of health delivery channel used to manage these ailments for the three years prior to the survey. The main ailments were defined as those for which a case was likely to be encountered on a monthly basis in any livestock type and for which preventive measure had to be taken to avoid recurrence. Trypanosomiasis and tick-borne diseases were the most reported diseases. These are vector-transmitted diseases, infecting both domestic and wild animals. The presence of wild animals in the settled areas could not be ruled out as contributing to high incidences of these diseases. GIT parasites, infecting mainly the young stock and small ruminants, were also common. CBAHWs were the delivery channel used most often for all categories of diseases in this area.

Table 16 -- Main ailments reported by livestock keepers and the health delivery channels used to manage the ailments between 1998 and 2001

Main ailment	% (n = 171) of livestock keepers using:		
	CBAHWs	Professionals[a]	Drug shops[b]
Trypanosomiasis[c]	64.2	20.8	32.4
Tick-borne diseases	63.7	24.0	41.7
GIT parasites	60.4	14.8	49.3
Coughing	51.0	14.7	39.5
Stock diarrhea	28.5	4.4	31.1
Wounds	4.9	1.5	4.8

Source: Survey data, 2001.

[a]Professionals in this case refers to formally trained animal health personnel including veterinarians and para-veterinarians in private and public practice.

[b]Use of veterinary drug shops entailed purchase of drugs from these outlets to facilitate own treatment.

[c]Livestock keepers' knowledge about trypanosomiasis and tick-borne diseases in the area could stem from the activities of NGOs (like ITDG, GAA) and government institutions (like KETRI, KARI) that have been actively involved in creating community awareness on disease and vector identification and control (KETRI 2000).

About 66.1 percent (n = 171) of the livestock keepers indicated that they had undertaken own treatment of their livestock during the year preceding the survey. Further investigations to identify the source of knowledge that enabled them undertake own treatment revealed that 45 of these livestock keepers (representing 39.8 percent of those undertaking own treatment) had learnt this skill from CBAHWs. The rest had either attended training (not linked to CBAHW programs), participated in farmer field days organized by drug companies, or learned from the extension staff. The drugs used in own treatment were purchased from veterinary drug shops, CBAHWs, and veterinary personnel. This implies that besides providing curative services, CBAHWs are also a source of animal health knowledge and veterinary drugs for other livestock keepers.

5.3 Characteristics of farmers using specific animal health delivery systems

Information collected on access to and use of different health delivery channels revealed that livestock keepers could be stratified in specific groups based on their health service channel preference and use. Of the 182 livestock keepers interviewed, about 43 percent used a combination of different health delivery channels, 29.1 percent used CBAHWs exclusively, 18.6 percent used only veterinary drug shops, and 4.4 percent used only trained veterinary personnel.[8] Table 17 shows the trends in the mean numbers of livestock kept for these groups of livestock keepers stratified by health service delivery channel.

[8] Eleven of these livestock keepers could not be conclusively classified in any of these categories.

Users of veterinarians' services had significantly higher numbers of animals than users of other health delivery channels, for all types of livestock. This finding was observed for all years from the onset of restructuring of animal health services in Kenya in 1991. Yet between 1992 and 2001 the number of cattle owned fell for all users of health service delivery channels. It declined by 19.5 percent for CBAHW users, by 15.9 percent for veterinary personnel users, by 37.7 percent for drug shop users, and by 32.8 percent for mixeed service users.

Table 17 -- Mean livestock owned stratified by health service delivery channel for 1992, 1997, and 2001

Mean	CBAHWs (s.d.)	Veterinary staff (s.d.)	Drug shops (s.d.)	Mixed service users (s.d.)
Cattle 1992	4.1 [a, b]	19.4[a]	11.4[b]	8.1[a]
	(5.5)	(17.8)	(19.4)	(13.03)
Cattle 1997	3.35[a,e]	17.9[a,b,c]	7.8[b,e]	5.75[c]
	(4.1)	(22.8)	(9.7)	(7.96)
Cattle 2001	2.85[a]	13.5[a, b, c]	6.41 [b]	5.44[c]
	(3.4)	(27.0)	(8.2)	(7.74)
Goats 1992	22.0[a]	74.0[a, b]	32.3[b]	38.0
	(22.1)	(85.7)	(45.3)	(62.1)
Goats 1997	25.4[a]	73.5[a, b, c]	30.4[b]	23.7[c]
	(26.5)	(82.2)	(29.2)	(27.5)
Goats 2001	23.6 [a]	53.0[a, b, c]	29.2[b]	28.1[c]
	(22.3)	(74.1)	(39.2)	(22.8)

Sheep 1992	2.1[a]	15.4[a, b, c]	3.5[b]	3.6[c]
	(5.5)	(15.9)	(7.7)	(8.9)
Sheep 1997	2.5[a]	13.1[a, b, c]	3.6[b]	2.9[c]
	(6.5)	(21.6)	(7.6)	(6.3)
Sheep 2001	3.2	7.6	4.0	2.0
	(7.3)	(16.5)	(10.7)	(4.8)

Source: Survey data, 2001.

Note: Values with the same superscript in a row are significantly different between groups using Kruskal-Wallis test; n=171; s.d. = standard deviation.

Users of CBAHWs, however, registered a 7.3 percent increase in goats for the same period, despite reductions for users of the other health delivery channels. These reductions in goats were 27.9 percent, 9.6 percent, and 26.1 percent for veterinary staff, drug shops, and mixed service users, respectively. This finding could be explained by the fact that CBAHWs more often attended to goats than to other animals (Table 4). On the other hand, the finding could be purely a sample phenomenon. For the mixed service users, the order of preference of use of these services was not investigated.

Table 18 summarizes the level of income and land held by the respondents stratified by animal health delivery channel. Users of veterinary staff had significantly higher aggregated crop income and total income than did users of other channels. On average, they also had larger (but not significant) parcels of land than users of other health channels (p = 0.05). Larger livestock herd or flock size and land owned are often associated with wealth. Therefore, users of services of CBAHWs had significantly less wealth than users of trained veterinary personnel. On the other hand, there was no significant difference in income level between users of the other health delivery channels. Given that the farmers share a similar habitat, it appears that the choice of a health service channel is influenced by, among other factors, the wealth status of livestock keepers. Past studies have established that clients of veterinarians are usually better resource endowed (Wamukoya, Gathuma, and Mutiga 1995). Similarly, Holden (1997) found that richer farmers tended to use CBAHWs more frequently than poor farmers, when users and nonusers of CBAHWs were compared. Her assessment, however, considered only CBAHWs and did not compare users of CBAHWs and with users of veterinarian services.

Table 18 -- Levels of incomes and land size stratified by health service channel choice

Description of income	CBAHWs users	Vet staff users	Drug shops users	Mixed users
Mean annual total farm income (Kshs)	25,688.27^{a}	350,062.50$^{a, b, c}$	23,327.48^{b}	25,907.97^{c}
Mean annual total income (Kshs)	35,654.53^{a}	385,912.50$^{a, b, c}$	28,746.84^{b}	36,977.18^{c}
Mean land acreage	19.84	42.37	22.45	35.78

Source: Survey data, 2001.

Notes: Values with the same superscript in a row are significantly different between groups using Kruskal-Wallis test; n = 171. US$1 = Kshs 78 (June 2001).

Table 19 summarizes the characteristics of the livestock keepers stratified by health service delivery channel.

Table 19 -- Characteristics of livestock keepers stratified by health service channel choice

Characteristic	CBAHWs Uusers (s.d.)	Vet staff users (s.d.)	Drug shops users (s.d.)	Mixed service users (s.d.)
Mean distance to nearest Veterinary drug shop	8.9[b] (6.0)	14.3[a] (10.8)	7.9[a, b] (6.0)	17.3[b] (8.8)
Mean distance to nearest Veterinary personnel	26.7[a, b] (17.6)	44.0[a] (20.1)	25.0[a, b] (19.9)	40.6[b] (17.7)
Mean distance to nearest CBAHW	1.87 (2.43)	2.13 (1.81)	1.79 (0.82)	2.23 (1.64)
Mean age in years	46.5 (11.2)	56.1 (15.5)	51.9 (14.3)	48.5 (14.5)
Years of formal education	2.3 (0.9)	2.6 (1.5)	2.2 (0.7)	2.2 (0.9)

Source: Survey data, 2001.

Note: Values with the same superscript in a row are significantly different between groups using Kruskal-Wallis test; n=171; s.d. = standard deviation.

There were no significant differences between different health channel users as far as age, formal education, and years of farming experience were concerned. Users of veterinary drug shops were nearer to drug outlets than users of other delivery channels. However, users of CBAHWs and veterinary personnel were not more advantaged than users of other channels in terms of their physical access to their sources of animal health services. This result could imply that factors other than physical access play a significant role in the choice of health delivery channel.

5.4 Variation in livestock productivity among users of different health delivery channels

Table 20 summarizes the breeding index (BI) and birth ratios (BR) stratified by health delivery channel.

On average, the number of births per cow for livestock keepers using veterinary personnel was lower than that of those using CBAHWs (p = 0.10). On the other hand, the breeding index for cattle herds belonging to users of veterinary personnel was not significantly different from that of users of CBAHWs (p = 0.10). This finding could be an indication that the absolute calf mortality rate was higher in herds of livestock keepers using services of CBAHWs than those using services of veterinary personnel. It appears that the higher average calving per cow, which has been attained within CBAHW users, is countered by lower calf survival.

Table 20 -- Breeding indexes and birth ratios of cattle and goats among livestock keepers stratified by health service delivery channel

	Animal health delivery channel			
Productivity service parameter	CBAHWs users (s.d.)	Vet staff users (s.d.)	Drug shops users (s.d.)	Mixed users (s.d.)
Cattle				
Breeding index (2001)	0.3466	0.6625	0.3595	0.3840
	(0.4115)	(0.4749)	(0.3837)	(0.3955)
Birth ratio[α]	0.4272[1,2]	0.3347[1]	0.3149[2]	0.4094
	(0.3847)	(0.2950)	(0.2695)	(0.3698)
Goats				
Breeding index (2001)	0.4545	0.4022	0.5563	0.5853
	(0.2972)	(0.3111)	(0.4292)	(0.3897)
Birth ratio[*]	0.4997[1]	0.2485[a,1,2]	0.4016[b,2]	0.6136[a, b]
	(0.4532)	(0.1547)	(0.2227)	(0.4117)

Source: Survey data, 2001.

Note: Values with the same alphabetical and numerical superscripts in a row are significantly different at $p = 0.05$ and $p = 0.10$ respectively between groups using Kruskal-Wallis test; n = 161 for goats and 101 for cattle; s.d = standard deviation.

[*]Birth ratios are averages for the years 1998/99, 1999/2000, 2000/01.

The case for goats was no different. The number of births recorded per doe was also lower among livestock keepers who used veterinary personnel compared with that of livestock keepers who used CBAHWs ($p = .10$). The BI between these two groups of livestock keepers was, however, not significantly different ($p = 0.10$).

Based on this comparison, CBAHWs appeared to provide services that enhanced the fertility of their clients' herds, probably because they are trained to handle common diseases and ailments in their area of operation and because of their proximity to their clients. Thus, they appear to have had a positive impact on herd productivity.

Livestock keepers who used a combination of health delivery channels had the highest birth ratio in goats, which was significantly different from that of veterinary personnel and veterinary drug shop users. In the year 2000 the proportion of livestock keepers that made contact with CBAHWs was 76.4 percent (n = 182). Fifty-three of them used CBAHWs exclusively. This implies that all the livestock keepers who used a combination of services (together with those who could not be categorized) used the services of CBAHWs, in addition to other channels.

6.0 PRIORITIES FOR PARTICULAR ANIMAL HEALTH SERVICES

Understanding the health service priorities of livestock keepers and the capabilities of CBAHWs should reveal ways of strengthening animal health service delivery through CBAHWs. Therefore, the CBAHWs who were assumed to be knowledgeable livestock keepers were asked to rank 10 health and production services in order of priority. This approach was used to minimize divergent priorities arising from differences in level of knowledge on livestock health among livestock keepers. The responses are given in Table 21. These were the services that had been mentioned as being important during the exploratory stage of this study. CBAHWs gave higher priority to preventive than to curative measures in management of livestock health, and these priorities are in accordance with newer veterinary practice philosophy.

The priorities mentioned by CBAHWs, however, seemed to downgrade those aspects of veterinary medicine that provide collective rather than private benefits. As shown in Table 21, on average, CBAHWs mentioned tick control as top priority, followed by preventative (prophylactic) and curative management of killer diseases and pasture improvement. These services offer private gains to livestock keepers undertaking them. Tsetse control and immunization against epizootic diseases have a strong public gain component and received lower ranking. Services with a private gain component that do not pose a great risk of death to livestock also received a lower ranking.

Table 21 -- CBAHWs' ranking of specific veterinary services (n = 35)

Type of service	% of CBAHWs ranking the service as: 1st	2nd	3rd	Average rank
Tick control	100	0	0	1.00
Preventive management of killer Diseases like trypanosomiasis	80	20	0	1.20
Training in pasture improvement and management	80	20	0	1.20
Curative treatment of killer diseases like ECF, trypanosomiasis	80	20	0	1.20
Tsetse control	74.3	25.7	0	1.25
Surveillance of notifiable Diseases	65.7	34.3	0	1.30
Immunization against killer Diseases like CBPP, CCPP	62.9	17.1	7.0	1.57
Artificial insemination for Upgrading of local breeds	48.6	25.7	25.7	1.77
Curative treatment of nonkiller Diseases like GIT parasites	28.6	60	11.4	1.80
Immunization against nonkiller Diseases like FMD	34.3	54.3	11.4	1.80

Source: Survey data, 2001.

Note: ECF = East Coast Fever,; CBPP = Contagious Bovine Pleuroneumonia; CCPP = Contagious Caprine Pleuroneumonia; FMD = Foot and Mouth Disease

The CBAHWs were then requested to give their opinion on who should offer the services prioritized and who should meet the cost. Their responses are given in Table 22.

Table 22 -- CBAHWs' opinions on delivery channels and financing sources of specific veterinary services

Type of service	Delivery channel and financing institution (mentioned by more than 65% of respondents)
Tick control	Public veterinary channel and CBAHW financed by livestock keepers
Preventive management of killer Diseases like trypanosomiasis	Public veterinary channel and CBAHW financed by livestock keepers
Training in pasture improvement and management	Mainly through CBAHWs with improvement costs met by livestock keepers
Curative care of killer diseases like ECF, trypanosomiasis	Mainly through CBAHWs with costs met by livestock keepers
Curative care of nonkiller Diseases like GIT parasites	Mainly through CBAHWs with costs met by livestock keepers
Tsetse control	Mainly through CBAHWs with costs met by government
General notifiable diseases Surveillance	Mainly through CBAHWs with costs met by government
Immunization against killer Diseases like CBPP, CCPP	Public veterinary channel and CBAHW financed by livestock keepers and the government
Artificial insemination for Upgrading of local herds	Public veterinary channel and CBAHW financed by livestock keepers and the government
Immunization against nonkiller Diseases like FMD	Public veterinary channel and CBAHW financed by livestock keepers and the government

Source: Survey data, 2001.

The responses indicated that CBAHWs were willing to provide veterinary services for which livestock keepers pay and also for those that they expect the government to finance. CBAHWs seemed to evaluate veterinary services solely in terms of perceived benefit to stock keepers, with little regard to whether or not they are able to pay for them. They have a good understanding of the perceived benefits associated with these services. Assuming that this is representative of livestock keepers' opinions, it can be concluded that the perceived benefits of these services are clear and that the payment method does not seem to have a strong effect on livestock keepers' priorities as would be expected from standard economic analyses.

In order to identify likely areas for strengthening the CBAHW programs, the CBAHWs were asked to group these services into:

- Services that they currently provide and for which veterinarians and para-veterinarians approve;
- Services that they currently provide and for which veterinarians and para-veterinarians do not approve;
- Services that they think they can provide (but currently they do not provide them) and for which veterinarian and para-veterinarians would perhaps approve; and
- Services that they think that they can offer (but currently they do not offer them) and for which veterinarians and para-veterinarians would ordinarily not approve.

The results, given in Table 23, show that CBAHWs can offer more services than they currently do.

Table 23 -- Classification of services undertaken by CBAHWs

		Veterinarians and para-veterinarians	
		Approve	Disapprove
CBAHWs	Services currently provided	1)Disease diagnosis and treatment (80%) 2)Providing information on notifiable diseases (74.3%) 3)Drug handling and use (57.1%) 4)Livestock extension services (22.9%)	1.Managing drug stocks for sale (17.2%) 2.Herbal medicine (17.1%) 3.Castration services (11.4%)
	Services not currently provided (but which could be provided)	•Handling cases of complicated deliveries (57.1%) •Basic surgical procedures (45.7%) •Artificial insemination (34.3%) •Participation in vaccination campaigns (31.4%) •Handling and administering of vaccines (31.4%) •Organization of field days and demonstrations (31.4%)	•Food hygiene (meat inspection) (20%) •Providing veterinary services outside the CBAHW project area (2.9%)

Source: Survey data, 2001.

Note: Figures in parentheses show the proportion of CBAHWs mentioning the response.

The services that CBAHWs could offer with the assistance of veterinarians and para-veterinarians include:

- Participation in vaccination campaigns and handling and administering of vaccines;
- Undertaking of basic surgical procedures;
- Organizing of field days and demonstrations to improve livestock keepers' knowledge;
- Provision of artificial insemination services; and
- Handling of some cases of complicated deliveries.

The CBAHWs currently offer mainly clinical services, but CBAHW participation in vaccination campaigns is not new. It has been tried successfully in the Afar region of Ethiopia and in southern Sudan (Catley and Leyland, 2001). In the case of the Afar region, Mariner (1996, quoted by Catley and Leyland, 2001) noted that CBAHWs achieved 84 percent vaccination efficiency using a heat-stable vaccine against rinderpest. This exceeded the 72 percent vaccination efficiency of Ethiopian government vaccination teams and compared favorably with conventional rinderpest vaccination campaigns in Africa generally, which achieved vaccination efficiency of 60–85 percent. Participation of CBAHWs in vaccination campaigns has also been reported in Senegal (Ly 2000), where they played a supportive role to the official veterinary technicians and also undertook nonmandatory immunizations.

Basic surgical procedures that can be undertaken by CBAHWs include de-horning, castration, and handling of wounds and fractures. Some of the CBAHWs in Senegal (also known as auxiliaries) were reported to own castration clips and scissors. The presence of these veterinary instruments within their toolkits indicated that their services were diversified and not limited to drug sales and injection services. The same can be applicable to CBAHWs in Kenya. Furthermore, these workers can offer artificial insemination services that are currently being promoted by government.

Advocating for management of drugs for the purposes of sale is likely to generate conflict between CBAHWs and veterinary personnel. Currently, there are at least 16 acts of Parliament that affect the veterinary profession in Kenya (Hubl, Gathuma, and Kajume 1998). Two of these acts have a significant impact on the practice of the veterinary profession in ASAL, namely the Veterinary Surgeons Act (Cap. 366) and the Pharmacy and Poisons Act (Cap. 244) of the laws of Kenya. Cap. 366 describes the qualifications required for registration by the Kenya Veterinary Board (KVB) to engage in private practice. This act recognizes only veterinarians (trained at the university level) as candidates for private practice and excludes the para-professionals (diploma and certificate holders) and CBAHWs. This legal provision imposes a constraint in the ASAL since very few veterinarians are currently willing to work in these areas. If this remains the case, approximately two-thirds of the country and its animals will be excluded from the benefits of privatization (Winrock 1992). Cap. 244 is even more stringent: it denies veterinarians the legal right to trade in veterinary drugs except for the purpose of treatment. This legally undercuts the establishment of veterinary drug shops that are the backbone of an effective CBAHW program. Furthermore, these acts do not provide any mechanism for persons not registered under Cap. 366 to seek legal redress for payment of any services they might have rendered to their clients.

Despite the restriction imposed by these legal instruments, several organizations have trained CBAHWs in several parts of the country. Some of these organizations include ITDG, Farm-Africa, Oxfam, GTZ, and DANIDA, among others. These organizations have had a difficult task trying to lobby for a change of attitude in the veterinary profession to recognize and accommodate the CBAHW model. These organizations have pursued policy advocacy by engaging in dialogue with key policy formulators in the veterinary field, making field visits to areas with CBAHW programs, and offering workshops for exchange of ideas and experiences related to CBAHW activities (ITDG 2000b, c). These efforts have resulted in some achievements, including a more attitude toward CBAHWs, to the extent that most are operational despite contravening the law. Unless the law is changed, however, investment in this area is bound to remain constrained.

7.0 CONCLUSIONS AND POLICY IMPLICATIONS

About 79 percent of livestock keepers interviewed had used the services of CBAHWs within a period of one year preceding the survey. Of these, about 37 percent (29 percent of the total sample) had used CBAHWs exclusively as a source of animal health services. The rest had used CBAHWs in combination with other channels like veterinary personnel and veterinary drug shops. This study argues that CBAHWs are providing animal health services in marginal areas and that their activities should be strengthened as one of the approaches to health service delivery.

7.1 Sustainability of the CBAHW model

CBAHWs' level of record keeping and professional development were the main attributes that determined their level of activity. Here is why: the limited initial training offered to the CBAHWs, it appears that livestock keepers are likely to acquire this knowledge from them and thereafter dispense with their services. Sixty-six percent of the livestock keepers interviewed reported that they had undertaken their own treatment of their livestock within a period of one year preceding the survey. About 40 percent of these livestock keepers revealed that they had acquired this skill from CBAHWs, and 91 percent of them reported that they had obtained the drugs used in treatment from veterinary drug stores. In order to remain financially viable, therefore, CBAHWs must be able to compete with veterinary drug stores for livestock keepers' business. Common sense says that even if the services of CBAHWs include advice and assistance in administration of drugs, livestock keepers will only be willing to pay for drugs priced at levels comparable to those offered by veterinary drug stores. CBAHWs have a competitive advantage over drug stores, however, in that they can lower their drug prices by selling individual doses to livestock keepers. Most drug packaging available from veterinary drug stores is meant to treat several animals, but CBAHWs can sell individual doses by treating several livestock keepers' animals within a few days. The administration of antihelminthics (for GIT parasites) and trypanocides (for trypanosomiasis) is particularly amenable to this practice.

It seems that CBAHWs who did not keep records had difficulty pricing drugs for subsequent sale. Those who kept records made a profit from their activities, whereas those who did not keep records may have been spending more on drugs than they could recoup from sales and therefore were unable to restock their drugs in time to continue offering services.

As far as professional development was concerned, the CBAHWs who regularly enhanced their level of animal health knowledge by attending refresher courses were more active than those who did not. Therefore it is logical to argue that CBAHWs need to remain more knowledgeable than ordinary livestock keepers on livestock health matters. Those who do not enhance their level of knowledge may find their services being demanded less as livestock keepers in their surroundings acquire an equivalent level of knowledge.

Enhancing the record keeping and professional development of CBAHWs will strengthen their capacity in service delivery. Livestock keepers will have easy access to veterinary inputs. They will be able to obtain treatment when required without having to walk longer distances to local veterinary drug stores. Furthermore, livestock keepers will be able to purchase the exact quantity of drugs required. This will reduce the cost of treatment. Livestock keepers will therefore be more inclined to treat or protect their animals with veterinary inputs. At the same time, more knowledgeable CBAHWs will be able to effectively advise livestock keepers on correct drug dosages, especially in areas where livestock keepers are illiterate and cannot follow instructions on drug packets. In the absence of CBAHWs, livestock keepers will have to rely on their own knowledge or on the advice provided by drug stores. Some studies have shown that some of these veterinary drug stores are manned by persons without any training in animal health (Bett 2001). Under such circumstances, the risks of drug misuse are likely to be greater than when livestock keepers are acting under the advice of CBAHWs. The CBAHWs, although clearly not as well trained as veterinarians or para-veterinarians, appear to provide an improvement over having a few resource-endowed livestock keepers correctly advised by veterinarians or para-veterinarians and the majority of the community receiving no advice at all.

This study has shown that CBAHWs have enhanced the capacity to delivery animal health services in marginal areas. The government can support the CBAHWs through training, and the CBAHWs can in return provide a frontline service in animal health delivery in these areas. There is thus a positive synergy between the government and CBAHWs that the government should consider exploiting.

7.2 Regulation and service delivery enhancement

The current licensing requirements for private veterinary practice exclude important types of animal health service providers. The role of CBAHWs is critical in the provision of animal health services in marginal areas, given the state of events and infrastructure in these areas. CBAHWs wishing to offer services to their communities should be encouraged to do so. Likewise, the CBAHWs currently offering services should be recognized and registered.

Nonetheless, a clear regulatory framework that encourages professional fair play should be enacted. The existing government animal health services structure has a clear and definitive role for veterinarians and para-professionals. Borrowing from this, a new legislative framework to regulate the activities of CBAHWs and give them an official role could be designed. By legitimizing the activities of these service providers, the state will be able to better monitor their performance and control malpractice. The formation of CBAHW associations could enhance training standards and encourage the formation of links with veterinarians. Such associations could also act as a link between CBAHWs and the Kenya Veterinary Board (KVB), whose mandate as a regulatory body should be widened to include a wide range of activities. Membership on the board should be expanded to include farmers or livestock keepers' groups. The three main stakeholders in the livestock industry, namely the government as the public trustee, the livestock producers, and the animal health service providers, would then jointly formulate policies on service delivery. The new board would act as an arbitrator in disputes and ensure maintenance of ethical standards in animal health practice. It is also within this expanded board that the operational framework of all service providers would be designed.

The current animal health services policy in Kenya is outdated because it was enacted before the wave of liberalization within the African continent. If a review is to be undertaken, a National Veterinary Drug Policy (NVDP) is fundamental and can have a positive impact not only on health delivery, but also on public health and the environment. This policy should include the establishment of an Essential Veterinary Drugs List (EVDL)—that is, a list containing those drugs that have been found to be efficacious and safe for prevention and control of important animal diseases. The EVDL should contain:

- The animal species for which a drug is used;
- Disease condition;usage (treatment or control); and
- Classification—that is, which category of animal health delivery channel should use the drug (qualified veterinarians only, para-veterinarians, CBAHWs, etc).

Such a drug policy could provide the rationale for embracing different components of animal health delivery systems, stimulate pharmaceutical industries to ensure quality control and regular supply, and allow CBAHWs to keep drugs to facilitate their activities. Such a list of drugs should, however, need frequent updating to incorporate advances in scientific knowledge.

7.3 Training and support of CBAHWs

The structure and content of training are vital factors in CBAHW programs. The technical content and scheduling of training courses should be planned in the context of the local livestock production system. Training could be expanded to include not only the identification, diagnosis, and treatment of common diseases, but also the handling and use of veterinary drugs and the expected role of CBAHWs in relation to veterinary authorities. Furthermore, the training could be expanded to include broader animal husbandry and production techniques and extension skills. These training and supervision activities should offer an opportunity for active involvement of local private and government veterinarians and para-veterinarians. The training package should be developed through close consultation with the livestock-keeping community, using participatory assessment techniques. It may also be preferential to conduct the training in villages rather than in urban centers. Emphasis should be given not only to animal species and health problems present in the area, but also to likely epizootic diseases that could afflict the area. All programs should emphasize the importance of refresher training and field visits. The activities of CBAHWs should remain community funded, whereas the government should handle the supervisory role.

7.4 Relevance of the findings to other countries

Problems in redesigning the structure of animal health service delivery to livestock keepers in response to the privatization process are common to most African countries (Holden et. al., 1996). Public sector, budgetary constraints and external pressures mean that livestock keepers must meet larger shares of costs of services increasingly provided by private operators. This study indicates that arid and semi arid lands – where millions of livestock and their owner reside -- do not provide conducive environments for high cost private veterinary practice. The results point to support for CBAHWs as a low-cost and sustainable strategy. However, supportive institutional and legal frameworks – which are currently lacking in most African countries – must first be developed. Further, CBAHWs require training in new skills and competencies if they are to be viable in the long run.

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Appendix 1: The Logistic Procedure

The logistic procedure fits linear regression models for binary or ordinal response data by the method of maximum likelihood. In this regression, the maximum likelihood estimates (MLEs) of the regression parameters are computed using the iteratively reweighted least squares (IRLS) algorithm. The output includes a table of parameter estimates and tests for the estimates. Using the parameter estimates, the estimated logit of the probability of an event (that is, a CBAHW remaining in active practice) at different level of the exogenous variables can be calculated as:

$$\text{logit}(p) = \boldsymbol{\pi} = \boldsymbol{\pi}_0 + \boldsymbol{\pi}^I * X^I \qquad (1)$$

where: $\boldsymbol{\pi_0}$ = intercept parameter estimate

$^{\boldsymbol{I}}$ = vector of slope parameter estimates

$\boldsymbol{X^I}$ = vector of exogenous variables

From equation (1) above, the predicted probability of an event at the given levels of exogenous variables can be computed as:

$$P = e^{\pi}/(1 + e^{\pi}) \qquad (2)$$

Other outputs of the logistic procedure include "the –2 log likelihood" (-2 log l) which gives the contribution of the exogenous variables and "the likelihood ratio chi-squared test statistic" for testing the significance of the exogenous variables included in the model. Also of importance is the "odds ratio," a measure of association which approximates how much more likely it is for the outcome to be among those with **I = 1** (active CBAHWs) than among those with **I = 0** (in active CBAHWs) at varying levels of any exogenous variable.

CHAPTER ELEVEN

Social Capital and Sustainable Agriculture in Kenya's Marginal Areas

Samuel Mwakubo, Gideon A. Obare, John Omiti and Lutta Muhammed

Social Capital and Sustainable Agriculture in Kenya’s Marginal Areas

1. Introduction

Agriculture has been and still is an important sector of the Kenyan economy. It contributes about 26 percent of the gross domestic product (GDP), accounts for 76 percent of national employment, 60 percent of total export earnings and 45 percent of government revenue. In the rural areas, where most of the population resides, about 80 percent of the people derive their livelihood from agriculture, and the majority of the farmers are smallholders. Their production accounts for about 70 percent of the total output and 50 percent of the gross marketed output (GoK 1997). Thus, agriculture is the engine of growth, and it is the sector that provides impetus to any meaningful development effort.

However, about 80 percent of the total land area in Kenya is marginal for agricultural production. Though these marginal lands are key areas for sustainability and biodiversity, they face frequent food shortages, are ecologically vulnerable, receive irregular and low amounts of rainfall, and suffer problems of environmental degradation such as soil erosion and soil mining. Soil degradation is increasingly regarded as a major—if not, the most threatening—environmental problem in developing countries. The main negative consequence of soil degradation is on-farm decline of crop production. With rising population densities, farmers are often caught in a Malthusian poverty trap, whereby their land does not provide enough food to feed the number of people in the family. At the same time, environmental degradation is increasing. Consequently, food availability and accessibility for large population groups may be severely reduced in the near future (World Bank 1992).

Nevertheless, these marginal areas can be made productive if farmers invest in their land. Such investments include terracing, manure application, tree planting, among others, to help conserve soil and water at both the community and farm household levels. These conservation efforts contribute toward food security and other national objectives, notably poverty alleviation and employment generation. Moreover, soil conservation also increases the long-term sustainability of farming systems.

Evidence of this sustainability has been observed in some areas. In the 1950s, the semi-arid Machakos District was a disaster area, as evidenced by soil erosion, low crop productivity, and poverty. However, as Tiffen, Mortimore, and Gichuki (1994) point out, today population has increased threefold but so has per capita output. Soil erosion has also slowed significantly. Machakos District now boasts some of the best-terraced land. There are other districts where conditions were similar to those in Machakos in the earlier periods, yet they have not undergone the transformation that Machakos has. Some of these districts include Taita-Taveta, Baringo, Kitui, Mbeere, lower parts of Keiyo District, and Tharaka. This raises the question of why Machakos made it, while the other districts did not. Can the "Machakos miracle" be induced on a large scale in other areas with similar conditions?

Investments in soil conservation may be undertaken when sufficient returns are expected, compared with the situation if no such investments were made. In addition and more importantly, farmers will make investments when they are assured that they will reap the benefits for a considerable period of time. These returns—in particular, monetary returns—can be related to many factors but are always influenced by social capital[9]. This is defined as civic social networks (Coleman 1988)[10].

The importance of social capital has long been recognized. In fact, the dominant theme in most development plans in Kenya has been “participation for progress” (GoK, 1989). In the Sessional Paper No. 10 of 1965 on African socialism and its application to planning in Kenya (GoK 1965), the government underscores the use of the Harambee spirit, whereby pooling of resources is seen as an important vehicle toward the mobilization of both private and public resources to foster development. Harambee is Kenya’s unique self-help movement, which has operated concurrently with official programs since independence. Resources pooled often include money, labor, materials, professional services, and organizational skills to build schools, roads, dispensaries, and cattle dips, among others.

Rural communities may be endowed with land, but they often lack skills (human capital) and organization (social capital) to turn the land into physical assets and protect it from degradation. Essentially, social capital influences the capacity of rural communities to organize for development. It also helps groups come together to raise their common concerns with the state and the private sector. In relation to the construction of terraces, social capital can increase access to knowledge and facilitate perception of the soil conservation problem and the need to do something about it; influence motivation for soil conservation work, peer encouragement, and labor exchange; and improve access to external inputs, including the state and civic society, beyond the immediate neighborhood. Directly, social capital affects soil conservation through information, motivation, labor, provision of tools, and terrace layout. Indirectly, it is through increased income for investment and peer encouragement to invest.

Although the on-going market reforms in Kenya aim to increase agricultural incomes, their effects seem at best to be mixed. Yet government policies are known to have considerable influence on the practices used by farmers, either encouraging or hindering investment in sound land improvement strategies. Institutional reforms, with regard to social capital and the imperfect functioning of the land market, are therefore receiving increasing attention as complementary policy devices for the improvement of farming systems. This is considered important especially within the framework of the ongoing policy debate on suitable incentives for improving sustainable land use systems and practices.

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[9] Technical and financial aspects are usually given overriding importance in soil conservation and land use management plans. However, it is recognized that social and institutional factors also matter (Krishna and Uphoff 1999).

10 Social capital is also defined as tacit knowledge, a collection of networks, an aggregation of reputations, and organizational capital, which can be interpreted in the context of organizational theory as a social means of coping with moral hazard and incentive problems (Stiglitz 1999).

1.1 Soil conservation programs and policies

The colonial government introduced soil conservation programs in the 1930s under the Department of Agriculture. The introduction of soil conservation programs was as a result of mounting international concern about soil erosion, population pressure on African reserves, and increasing incidence of drought (Anderson 1984). The colonial government committed funds to anti-erosion measures, particularly in the semi-arid districts of Machakos, Kitui, and even Taita-Taveta. Some of these measures were contour trenching, destocking, planting Napier grass, and rotational grazing for the grazing lands and cut-off drains and terraces for farming areas.

In 1938, a Soil Conservation Service was established. Funds were later advanced through the African Land Development Board (ALDEV) and then through the Swynnerton Plan[11] in the 1950s. With the help of chiefs, the extension service coerced the people into undertaking soil conservation measures. After independence in 1963, the government continued with the soil conservation measures under the Ministry of Agriculture. These efforts were complemented by the Permanent Presidential Commission of Soil Conservation and Afforestation, established in 1982, which built demonstration sites for gully control, cut-off drains and terraces, fodder establishment, afforestation, and pasture reclamation on badly eroded lands (Tiffen, Mortimore, and Gichuki 1994).

In 1974, the Swedish International Development Agency (SIDA) began to support soil and water conservation—the construction of cut-off drains and terraces as part of "food for work" schemes—through the Ministry of Agriculture. The Danish Development Agency (DANIDA) also supported soil conservation works; it is still running some programs in Kitui, Makueni, and Taita-Taveta districts. Nongovernmental organizations (NGOs) have also contributed to soil and water conservation activities, especially since the drought of 1984. These include the Catholic Diocese of Machakos, the Green Belt Movement, Action-Aid, and the Kenya Institute of Organic Farming. They support community mobilization for self-help, provide financial assistance for minor rehabilitation works, and promote better farming methods. They work mainly with self-help groups.

Another approach to soil conservation, the catchment method, was developed with the support of SIDA. Local communities were involved in the selection of catchment areas and even initiated the process by making a formal request. The rationale for this approach was its cost-effectiveness and its "public good" characteristic. Moreover, work groups provided a method of cost sharing by pooling labor at no cash cost to the farmer. Farmers in a group moved from one farm to the other, laying conservation structures with guidance from the extension staff. Measures were introduced to facilitate terracing and other conservation work, such as cash payments, food for work, and tools for work. In the short term, it was noted that the food and tools for work schemes were effective insofar as the group work enabled poor farmers to construct terraces. However, once the incentives were removed, work slowed down considerably and morale dropped (Kariuki, Onduru, and Muchoki 1994).

Phase 1 of the arid and semi-arid lands (ASAL) component of the National Soil and Water Management Research Program (NSWMRP) was initiated in 1992, focusing on water and fertility management and soil conservation (Itabari 1995), while Phase 2 ran from 1995 to 2000. This program maintains links with the Soil and Water Conservation Department of the Ministry of Agriculture and a large number of organizations involved in soil management around the world. It is the primary source of techniques for soil conservation. More recent

[11] The plan was to improve African agriculture by allowing farmers to grow cash crops and providing credit.

methods such as Farmer Field Schools and Participatory Learning and Action Research (PLAR) have also been applied.

In 2000, the Kenya Agricultural Research Institute (KARI) formulated the Agricultural Technology and Information Response Initiative (ATIRI), whose main goal is to work with partners to meet farmers' information and technology demands. In order to catalyze the process of service delivery to farmers, ATIRI brings together government, community-based organizations (CBOs), NGOs, and farmers to make demands on KARI through submission of proposals (KARI 2000). Many CBOs operating within Machakos, Makueni, Mwingi, Kitui, and Taita-Taveta districts have benefited from ATIRI.

1.2 Statement and significance of the problem

Soil erosion is a serious problem in Kenya's marginal areas. The effect has been a decline in agricultural productivity with a consequent increase in food insecurity. Thus, soil and water conservation is a key ingredient for sustainable agricultural development. The social capital underpinning the success of these measures has had little or insignificant attention in empirical literature. This is apparent in relation to its effects in land and resource management in ecologically fragile areas for agricultural use. Also, studies have shown that there is a positive relationship between increased slope and soil erosion (Okwach, Palis, and Rose 1992; Norton-Griffiths 1986), attributable to increased erosive power and velocity of overland flow as the slope increases.

If physical and human capital facilitates productive capacity, so must social capital. Yet the role of social capital in motivating the initiation and accomplishment of soil and water conservation and as a catalyst in overcoming production constraints, imposed by both the environment and economic institutions, is rarely a major consideration in policy and policy instrumentation.

Apparently, different forms of social capital have different effects on households' engagement in production and resource management. It follows, therefore, that identifying the social capital forms and their functional relationship to resource management, agricultural development, and sustainable land use should be core to explaining resource use management and agricultural productivity. However, no such relationship has been established. In addition, no documentation has been done on how different forms of social capital impact on land management practices in agriculturally marginal areas of Kenya. The available studies in this area (Tiffen, Mortimore, and Gichuki 1994; Pagiola 1993, 1994; and Lindgren 1988) only discuss labor exchange programs, one of the forms of social capital, without causal linkages and evidence showing how such conclusions are arrived at. In Tanzania, for example, Narayan and Pritchett (1997) report about the effectiveness of social capital in reducing poverty.

The functional relationship between social capital and sustainable land use in a marginal agricultural setting should provide a basis for integrated policy intervention with households and the community as the focus. In the past, policy and practice tended to be preoccupied with changing the behavior of individuals rather than of groups or communities; yet the latter are also crucial (Pretty and Ward 2001). Moreover, marginal areas, at least in Kenya, are associated with higher risk of crop failure and as a result, soil conservation is an important input with consequences for both perception and management of production risk at the farm and community levels. Thus, there are social capital–conservation relationships that may be significant in the context of marginal agriculture.

1.3 Research Objectives and Hypotheses

Objectives of the study

The overall objective of the study is to investigate farm-level social capital in marginal areas and evaluate its effects on perceptions of soil erosion problems, soil conservation investments, resource use patterns, and agricultural productivity.

The specific objectives are

- To study and characterize forms or attributes or elements or types of social capital;
- To investigate how “different forms” of social capital influence farm-level soil and water conservation investments;
- To investigate whether there is a link between social capital, resource use, and agricultural productivity; and
- To provide policy implications regarding social capital and soil conservation.

Hypotheses of the study

The following hypotheses were posed for testing.

- There are various elements of social capital, which have different and significant effects on soil and water conservation.
- Social capital has a positive significant effect on resource use.
- Social capital has a positive significant effect on agricultural productivity.

2. Conceptual framework

In this section, we describe how we defined, conceptualized, measured, and applied different measures of cooperative capacity; how these measures relate to the explanatory factors hypothesized to affect cooperation, and the impact of these indicators on a variety of outcomes observed at both the community and household level.

2.1 Definition of social capital

Social capital is a relatively new term in the lexicon of economists (Katz 2000) and a hotly debated concept in modern sociology (Coleman 1990; Putnam 1993), though the role of interpersonal relationships in human relations have long been recognized by social scientists (Coleman 1988; Granovetter 1985). However, the concept has been seldom used in economics (Fafchamps and Minten 1999; Barr 1997; Narayan and Pritchett 1996). This is probably due to the diversity of definitions of what social capital is and is not at the operational level (Krishna 2003; Fafchamps and Minten 1999),although there is a high consistency in the definitions of social capital at the general level, including the forms and dimensions it embraces (Narayan and Cassidy 2001).

Two possible meanings of social capital can be inferred from the literature. First, it may be seen as a stock of trust and emotional attachment to a group or society that facilitates the provision of public goods (Fukuyama 1995; Greif 1993; Coleman 1988; Putnam, Leonardi, and Nanetti 1993). Second, it may be seen as an individual asset that generates private benefits to a single individual or firm (Granovetter 1985; Montgomery 1991; Aoki 1984). Krishna (2003) argues that while the concept of social capital is valid universally, the measure of social capital will vary by context, and it must be related in each case to aspects of social relations that assist mutually beneficial collective action within that particular cultural context. It is this imprecise meaning, which makes measurement difficult, that has caused economists to be wary of using the concept.

The soil conservation model described below is adopted from the sustainable livelihood framework, which offers a holistic approach for assessing resources and assets that are available to households. It analyzes how these are linked to the strategies that are used to reach desired household welfare outcomes, and it summarizes the pathways by which household resources are manipulated to achieve attainment of welfare needs. Social capital is one of the most important resources available to the household. Here we restrict ourselves to two dimensions of social capital—structural and cognitive—to examine the social capital manifestations in membership density, diversity, participation in decisionmaking in the groups, and the perception of trust, solidarity, and cooperation in groups or organizations.

2.2 Perception of the soil erosion problem and investment in terraces as a two-stage process

The effects of social capital as defined influence decisionmaking in a soil conservation model illustrated in Figure 1. In this model, we attempt to capture the main factors that motivate households to adopt soil conservation measures. The model illustrates how social capital and other factors directly or indirectly influence the soil erosion problem and terrace investments. It thus informs the discussion on how farmers convert social capital into physical/natural capital, which in this research is indicated by the terrace investments. In this model, the decision to invest in soil conservation practices may be conditioned by the individual household's perception of the soil erosion problem and possibly the level of social capital. The perception of the soil erosion problem may in turn depend on social capital, existing institutional and policy factors—particularly at the macro level—household characteristics, location or area-based factors, and farm characteristics.

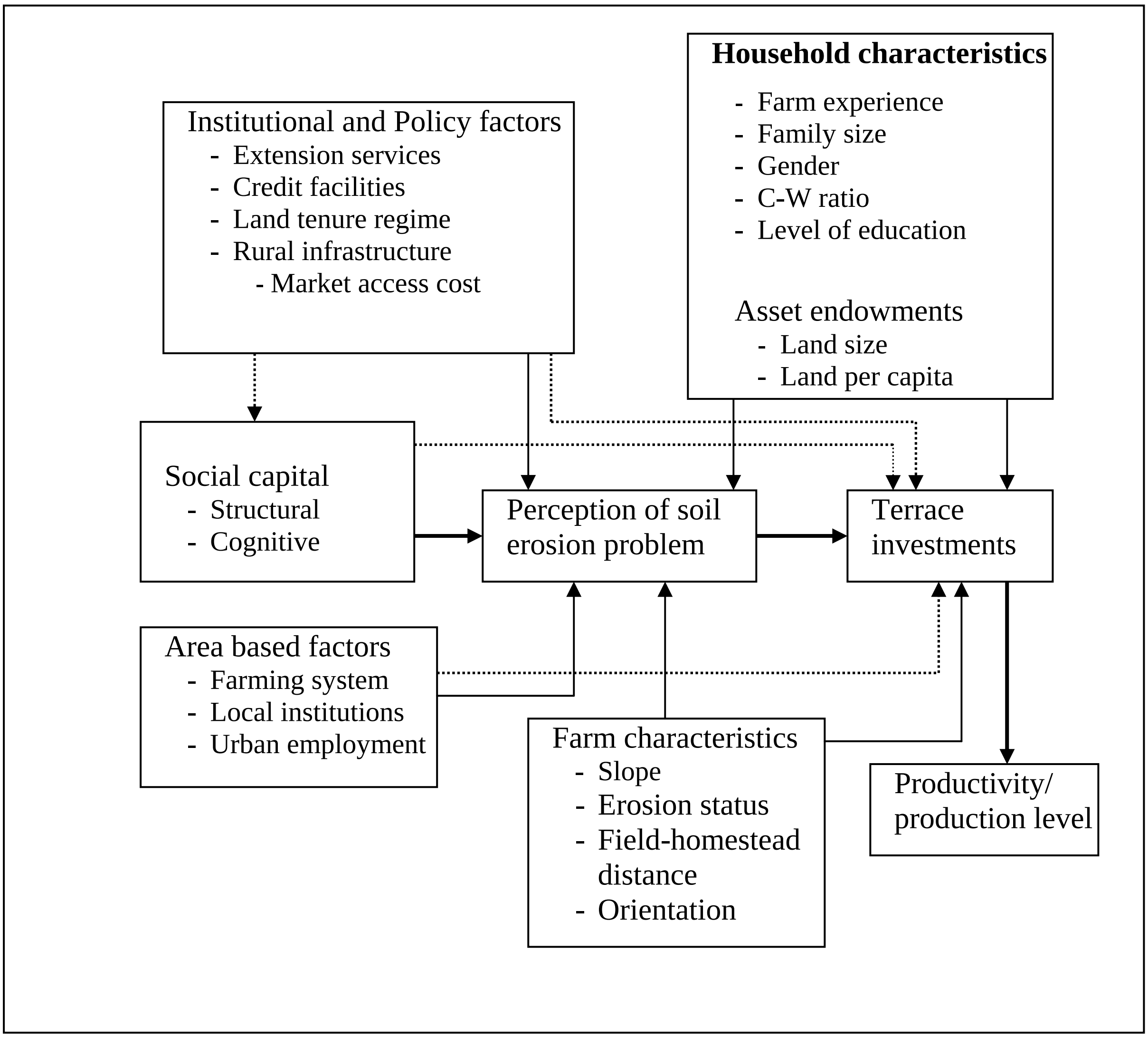

Figure 1. Soil conservation model: The framework

The factors in the conservation decision model may affect smallholders' terrace investment directly through the perception of soil erosion. Therefore, the process of terrace investments can be captured in two stages. In the first stage, the household appreciates the level of soil degradation, and therefore there is a perception of the soil erosion problem. This process will depend on national institutions that bear on policy and institutional factors, individual household characteristics, farm characteristics, area-based factors, and social capital stock. This process is latent and cannot be observed. In the second stage, we observe the terracing activity, which depends on the level of perception, national institutional and policy factors, household characteristics, farm characteristics, area or location-based factors, and probably the level of social capital of the household.

Various factors are assumed to influence the level of perception in the first stage, which can be captured in a perception model. These factors include social capital (structural and cognitive), household-specific characteristics (education, farming experience, family size, gender, land size, livestock, land per capita, wealth status and household income), farm-related characteristics (slope, erosion status, homestead to field distance, and farming orientation), area-based factors (farming systems, local institutions and urban employment linkages) and macro-level institutional and policy factors (extension services, credit facilities, land tenure regime, and physical infrastructure endowments).

Social capital implies the social resources upon which people draw in the pursuit of their livelihood objectives. By improving the efficiency of economic relations, social capital can help increase peoples' incomes (World Bank 1994) in addition to facilitating continued agricultural yield increases (Uphoff and Wijayaratna 2000; Admassie, Mwarasombo, and Mbogo 1998; Uphoff, Esman, and Krishna 1998). In its two dimensions, social capital will facilitate access to information by reducing the cost through sharing in groups or networks and, thus, the internalization of the soil erosion problem. Social capital may facilitate reciprocal insurance arrangements, thereby decreasing household or individual risk, or it may be used to facilitate access to credit or information (Fafchamps and Minten 1999; Gabre-Madhin 2001), thus addressing market failure that is caused by asymmetric information (Arrow 1999). Consequently, we postulate that a high level of social capital is reflected in a corresponding high level of perception of the soil erosion problem, especially in areas where this problem can be observed.

Furthermore, we expect that availability and access to extension services will increase the level of awareness of soil erosion if a policy exists that is geared toward arresting the problem in soil erosion-prone areas, in which case the perception of individual households will be high, with the corresponding consequence of increased terracing investments. Moreover, we expect households who frequently interact with extension staff to be more cognizant of the problem.

It is known that investments in long-term soil conservation measures require tenure security. Katz (2000) argues that social capital can overcome the disincentives for natural resource management brought about by informal or poorly defined property rights—titling reduces defensive land clearing and provides greater incentives for demographic stability, particularly in agricultural frontier areas. It is therefore likely that secure tenure rights would improve perceptions of soil erosion as a problem.

The link between access to credit and heightened perception is not clear, since there is no theoretical basis. However, it has been shown that when institutional credit markets are highly imperfect, inherited endowments (including land and the embedded soil erosion status) become central in the ability to acquire productive assets (Pender and Walker 1989. An increase in farming is expected to raise perceptions of the soil erosion problem and its associated economic impacts (Shiferaw and Holden 1998; Ruthernberg 1980; Templeton and Scherr 1997). Diversification out of agriculture is likely to reduce pressure on land or to decrease the dependency of a household on farming as a primary income source. Therefore, increased off-farm orientation is expected to lower perceptions of soil erosion as a problem. Family size will impact on the land-man ratio—its effect, from the Boserupian perspective (Boserup 1965), would be to increase the impetus to invest in land quality. Thus, one may argue that the decrease in soil erosion following autonomous investments will reduce the threat and its perception.

Once their perceptions have been internalized, the farmers are likely to move into the second stage, which involves a response to the perceived problem. There are two possible responses: either the farm household invests in terraces, or it does nothing about the problem. The two outcomes are observable. We postulate that this outcome will be a function of perception, institutional and policy factors, household characteristics, the stock of social capital that a household possesses, farm characteristics, and area- or location-specific factors.

Recognition of the problem is essential for soil conservation investments (Templeton and Scherr 1997; Tiffen, Mortimore, and Gichuki 1994); consequently, perception will be strongly linked to the level of terrace investments. An increase in the consumer-worker ratio, however, reduces the ability of households to meet their subsistence needs, especially where land pressure is high (Holden 1991), and may subsequently lead to a reduction in terrace investment. We also infer a positive relationship between education and terrace investments, as education embodies acquisition of managerial skills.

Empirical evidence suggests that older farmers are more likely to reject conservation practices (Gould, Saupe, and Klemme 1989) and new productive practices (Bellon and Taylor 1993). Land tenure insecurity has been found to deter investment in resource management and conservation (Hayes, Roth, and Zepeda 1997; Reardon and Vosti 1992; Nowak 1987). Thus, we assume that farmers who perceive the security of their land tenure to be insufficient would be less willing to invest in terraces.

Where credit markets are imperfect, a larger farm size, often related to wealth, may mean that such households are not so constrained by lack of liquidity that they cannot invest in land quality management. [CHANGES OK?] Since the type of house variable is correlated with wealth and welfare of rural households, we expect it to influence soil conservation positively. The physical erosion potential has been shown to positively affect adoption decisions (Gould, Saupe, and Klemme 1989; Ervin and Ervin 1982). Consequently, we hypothesize the slope of cropland to be positively related to intensity of terrace structures.

The net effect of diversification (out of agriculture) on land quality investments is theoretically not clear (Hayes, Roth, and Zepeda 1997; Gould, Saupe, and Klemme1989). Increased dependence on nonagricultural activities may lower the economic significance of soil erosion. Alternatively, off-farm income may ease the liquidity constraint for soil conservation investment or the purchase of soil fertility-enhancing inputs.

According to Pagiola (1995), poor farmers may have more incentive to adopt sustainable farming practices than other farmers because future harm from degrading a resource is potentially unbounded. Yet if we consider that soil conservation in the form of terracing is labor-intensive, then we would expect wealthy farmers capable of overcoming the labor constraint to invest in more terracing, all else being equal.

2.3 Productivity as an outcome of terracing

Investments in terraces reflect the agents' expectations concerning growth in production. Land productivity can act as an indicator of growth in production since, in most cases, land is a major constraint in expansion of agricultural production *ceteris paribus*. In the soil conservation model presented in Figure 1, a productivity variable has been included as an outcome of terrace investment. Social capital may facilitate reciprocal insurance arrangements, thereby decreasing household or individual risk, or it may be used to facilitate access to credit or information that would lead to increased productivity and better marketing opportunities (Malucio, Haddad, and May 1999; Gerani 2001). We postulate, therefore, that crop output per acre will be a function of conventional factors of production in addition to the elements of social capital.

3. Research methodology

In this section, the study design is discussed, including selection of the study areas, survey methods, measurement of variables, and methods of data analyses.

3.1 Selection of the study sites, sampling frame, and data collection methods

The study areas are in agro-ecological zone IV, which ranges from semi-arid to semi-humid, depending on altitude. (Jaetzold and Schmidt 1983) The Lower Highland Zone has 115 to 145 growing days (a medium to medium/short growing season) and an annual mean temperature between 15°C and 18°C. The Upper Midland Zone has between 75 and 104 growing days (a short to very short growing season) and a mean annual temperature between 21°C and 24°C. Raising cattle and sheep and growing crops such as barley are recommended activities for the Lower Highland zone, while growing sunflower and maize crops are recommended for the Upper Midland zone.

The data for this study come from a survey of rural households in Machakos and Taita-Taveta districts. Four sublocations were chosen in each district on the basis of terracing density; the number of terraces per acre and physical infrastructural endowments such as roads. Two sublocations with higher terracing density were selected in each district, one with a higher endowment of physical infrastructure and one with lower. Likewise, two sublocations with lower terracing density but higher and lower physical infrastructural endowments were also selected. A village was then selected randomly from each of the sublocations. The villages selected in Machakos District were King'elu, Kaliluni, Nzololo, Kyamuange, and Kekesunyi; in Taita-Taveta District, Mwakimoi, Mwakiki, and Kale were selected. The survey was carried out using a structured questionnaire in each district, with about 40 households chosen randomly in each village. In addition, village profiles using focus group discussions were conducted in an effort to find out about groups that exist in the villages and their relation to soil and water conservation.

3.2 Description and measurement of variables

A description and measurement of the model variables are given in Table 3.1. In this study, the length of terrace per hectare[12] is a proxy for soil conservation investments. The enumerators asked each farmer about the number of terraces on each parcel of land and the average length. This was confirmed both by pacing out the length and by actual measurement. Because of the heterogeneous nature of the crops grown—maize, beans, bananas and, citrus, among others—the market value is used to obtain the aggregate crop output (*CROPAC*) for the whole farm, As well as a lagged value of crop output (*LCROPAC*), which is the value of crop output the year before the survey (2002). This is essential since there are always lags in effects, especially with farmers in agricultural systems. What is termed agricultural productivity (*CROPHA*) is crop output per acre. Other aspects such as livestock and trees are not included. Access costs (*ACCESCOS*) are the transport costs per person to the major market in each district in Kenya shillings. As for attributes of social capital or the extent of "connectedness,"[13] four measures of social capital are used. They

[12] Terrace construction is the major soil conservation measure in the study area (Zaal 1999; Mwakubo 2003).

[13] Gabre-Madhin (2001), for instance, measures social capital by the number of persons in the grain trade business that the trader knows personally.

include density of membership in groups,[14] diversity of membership, participation in decisionmaking, and cognitive social capital.

At the household level, density of membership is the number of people in each household. This can generate high levels of trust and have a mitigating influence on the costs of information search, contract negotiation, and enforcement (Bates 1999). However, terrace construction is largely undertaken by hired or communal labor, at least in Machakos District.

Membership diversity is measured by rating members of a group according to five criteria: religion, gender, age, political affiliation, and education. A diversity score is then calculated for each organization by assigning a one or a two: (a value of one for each criterion indicates that members of the organization are "mostly from the same" religious affiliation, gender, and so on, while a value of two indicates that members mostly come from different groups). These scores are then summed up per household. This index procedure assumes that each criterion has the same weight in measuring the overall diversity of membership. As Putnam (1993) suggests, diversity can spur community members to seek out others like themselves, caring less about those they do not know, and this can limit the level of social capital and its effectiveness.

Participants generally believe that organizations that follow a democratic pattern of decisionmaking are more effective than others. To determine whether an organization is democratic, respondents were first asked to evaluate the relative roles of the leader and the members in reaching decisions andsecond, to evaluate the effectiveness of the organization's leader. The two responses can then be combined into a "democratic functioning score" to determine the diversity score as shown below:

1 = the leader decides and informs the group,
2 = the leader asks group members for their views and then decides,
3 = the group members hold a discussion and decide together

and,

1 = the leader is not effective,
2 = the leader is somewhat effective,
3 = the leader is very effective.

These scores would be added together to give an index of group diversity for each household.

[14] These are local groups such as labor exchanges, water associations, funeral associations, and women's groups.

Table 3.1. Description and measurement of variables

Variable	***Description***	***Measurement***
TERRACE	Length of terrace	Meters per hectare
SLOPE	Slope of land parcels	Simple scale: 1= low flat, 2= lower slope, 3 = mid slope, 4 = upper slope
TENURE	Land tenure regime	Increasing scale of tenure security (1 to 7)
DISTH	Distance from homestead to crop fields	Meters
LCROPAC	Lagged crop output	Kenya shillings
CROPAC	Crop output per year	Kenya shillings
CROPHA	Agricultural productivity	Kenya shillings/ha
MEDENS	Membership density	Simple increasing scale
MEDIVE	Membership diversity	Simple increasing scale
PARTIC	Participation in decision-making	Simple increasing scale
COGNIT	Cognitive social capital	Simple increasing scale
EDUC	Education of household head	Number of years in formal schooling
WEALTH	Wealth of household	Type of house/roof
SEX	Sex of household head	1 = male, 0 = female
FAROR	Degree of farm orientation	Proportion of off-farm income in total household income
HHS	Household size	Number of persons in the household
FAMCA	Farm size per capita	Hectares per person
INC	Household income	Kenya shillings
AGE	Age of household head	Number of years
ACCESCOS	Access costs to markets	Kenya shillings
ERODE	Farm eroded or not	1= eroded, 0 = not eroded
CWORK	Consumer-worker ratio	Fraction or proportion
PERCEP	Perception	0 = none, 1= low, 2 = moderate, 3 = high, 4 = very high
EXT	Visited by extension staff?	0 = No, 1 = Yes
LOC	Where household is located	0 = Taita-Taveta, 1= Machakos
MANHA	Manure use	Kilograms per hectare (kgs/ha)
LABHA	Labor use	Man-days per hectare

The last measure of social capital (cognitive social capital) is organized around three themes: solidarity, trust, and cooperation. Respondents were asked whether they (1) strongly agree, (2) agree, (3) disagree, or (4) strongly disagree to some general statements. These were then summed up according to increasing levels of social capital. This type of aggregation obviously involves strong assumptions about underlying common scales. Yet in practice, this method is commonly used and the resulting indicators have proven useful, especially in the context of multivariate analysis (Grootaert and van Bastelaer 2002). Cognitive social capital raises the perception of sources of possible support and know-how and their potential reliability, which may find their way into increased soil conservation investments.

3.3 Data analysis methods

Two types of data analysis, qualitative and econometric, were carried out in order to provide a proper balance. Although some issues emerge from both types of analysis, others are only captured well using one method of analyses or the other. Using both is likely to yield a deeper understanding of social capital and soil conservation and to inform policy design better.

With qualitative analysis, the basic objective was to map social capital, its characteristics, and patterns over time. This was achieved through group discussions with village members, which makes it possible to infer which forms of collective action are successful. Particular attention was given to actions linked to soil and water conservation. In particular, the discussions focused on the history of terracing drives in the communities, the proportion of villages terraced under collective action, participation rates, collective action and gender, and farmers' attitudes toward collective action. Finally, the group's perceptions on strengthening the positive forms of social capital and reducing the negative ones were sought.

3.4 Specification of the empirical models

Before any econometric analysis could be done, descriptive statistics were examined with a view to understanding the distribution of the data. Measures of central tendencies, box-plots, cross-tabulations and t-tests were conducted to explore the differences in types and amounts of soil conservation investments among various aspects of social capital. The econometric packages used were SPSS and LIMDEP.

Perception of soil erosion problem

The decision on whether to invest in soil conservation measures and the level of investments depends a great deal on whether a farmer perceives that there is a soil erosion problem or not. The conceptual framework is a model that predicts how a farmer on marginal lands with given attributes will perceive the problem. The Probit model is used to identify the important factors explaining the perception of soil erosion problems. The general function of the perception model is

$$\begin{aligned} &PROB(PERCEP) = f(SLOPE, TENURE, DISTH, LCROPAC, MEDENS, MEDIV, \\ &PARTIC, COGNIT, EDUC, WEALTH, SEX, FAROR, HHS, FAMCA, INC, AGE, \\ &ACCESCOS, ERODE, CWORK, LOC) \text{..} (1) \end{aligned}$$

Decision to terrace and terracing intensity

A censored Tobit is used to model adoption of terracing technology and the intensity of terracing on the decision to terrace in the first place. This is because information on the dependent variable from population is limited in its range, especially for the nonadopters. Observations on the dependent variable, corresponding to known values of independent variables, cannot be observed or are missing. Exclusion of nonadopters results in sample selection bias and attendant biases in the estimated coefficients (Heckman 1979; Feder and Umali 1993). Estimation of Ordinary Least Squares (OLS) with a dichotomous dependent variable would be inappropriate because resulting parameters would be inefficient due to the heteroscedastic structure of the error term.

This model makes estimates consistent and is specified as

$$\begin{aligned}&TERRACE = f(SLOPE, TENURE, DISTH, LCROPAC, MEDENS, MEDIV,\\&PARTIC, COGNIT, EDUC, WEALTH, SEX, FAROR, HHS, FAMCA, INC, AGE,\\&ACCESCOS, ERODE, CWORK, PERCEP, LOC)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)\end{aligned}$$

Social capital, terracing intensity, and crop productivity

The impact of social capital on crop productivity and vice-versa may or may not be direct. Alternatively, some factors may simultaneously affect terracing intensity and crop productivity, in which case, we are dealing with a simultaneous equations model in that two or more endogenous variables are determined jointly within the model, as a function of exogenous variables, predetermined variables, and error terms. This simultaneity induces correlation between the regressors and error terms of each equation in the systems, thus causing OLS to be inconsistent in estimating parameters.

As a result, the main estimating technique that is used is the Two-Stage Least Squares (2SLS). This is essentially a single-equation method, which does not use all the information contained in the detailed specification of the rest of the model. Although, in principle, information on the complete structure, if correct, will yield estimators with greater asymptotic efficiency than that attainable by limited-information methods (Green 2000), full information methods require extensive data, which in most cases is not available. In addition, they often suffer from misspecification problems.

Since we are dealing with censored variables, the Heckman Two-Stage Estimation Technique is used (Maddala 1983). In this procedure, an inverse mills ratio (IMR) is computed and then included as a separate explanatory variable in the estimation process.

The Two-Stage Least Squares equation is given below:

$$\begin{aligned}&TERRACE = f(SLOPE, TENURE, DISTH, LCROPAC, MEDENS, MEDIV,\\&PARTIC, COGNIT, EDUC, WEALTH, SEX, FAROR, HHS, FAMCA, INC, AGE,\\&ACCESCOS, ERODE, CWORK, PERCEP, LOC, IMR)\ldots\ldots\ldots\ldots\ldots\ldots(3)\end{aligned}$$

Social capital, resource use, and agricultural productivity

Social capital may influence resource use such as labor, manure, fertilizer, and pesticides and thus eventually have a bearing on agricultural productivity. It is also possible that social capital may directly influence crop productivity. In such a case, we are dealing with multivariate regression models, as the same variables appear in more than one regression function. Such a system is subject to cross-equation restrictions besides the fact that error terms are correlated. The system of equations is thus estimated together as seemingly unrelated regressions (SURE) as

$$CROPHA = f(MANHA, LABHA, MEDENS, MEDIV, PARTIC, COGNIT) \quad (4a)$$

$$LABHA = f(DISTH, HHS, INC, MEDENS, MEDIV, PARTIC, COGNIT) \quad (4b)$$

$$MANHA = f(TENURE, DISTH, EDUC, INC, EXT, MEDENS, MEDIV, PARTIC, COGNIT \quad (4c)$$

4. Descriptive analyses of socioeconomic characteristics and social capital with relation to soil and water conservation

In this chapter, results are presented and discussed. The socioeconomic characteristics of sampled households are presented in section 4.1, the qualitative analysis of social capital in section 4.2, and the perception of soil erosion problems in section 4.3.

4.1 Socioeconomic characteristics of sampled households

About 86 percent of the heads of the sampled households were male, while about 14 percent were female (Table 4.1). The results are not surprising since households in Sub-Saharan Africa are generally headed by males. When a man dies, it is normally the first-born son who assumes headship. The proportion in the individual countries is more or less the same. Sex of the household head is an important issue: men are perceived to have better access to resources (Mwakubo 1994) and thus are able to finance soil conservation investments.

Table 4.1. Sex of the head of the household

Responses	Machakos		Taita-Taveta		Combined	
	Frequency	%	Frequency	%	Frequency	%
Male	147	91.9	130	80.7	277	86.3
Female	13	8.1	31	19.3	44	13.7
Total	160	100	161	100	321	100

Source: Field survey, 2003

The study also revealed that about 90 percent of the farmers construct *fanya juu* terraces (where the soil is thrown upslope during construction). This type of terrace is popular with farmers because they conserve both soil and water. They are also helpful in harvesting water from roads and footpaths. Earlier studies also confirm this finding (Mwakubo 2003; Nixon et al. 1993).

Table 4.2 shows the households that had contact with extension services in the previous year. Generally, extension contacts were minimal. Less than a third of the farmers had access to extension; yet extension is important. In traditional agriculture, farming skills and knowledge were passed from one generation to the next through "on-the-job training," that is, children working alongside parents. This transfer pattern, however, is inappropriate for agriculture undergoing transformation, hence the need for a modern extension service. The extension service, therefore, has a vital role to play with regard to the flow of information. Theoretically, extension services help farmers to improve the efficiency of the productive factors at their disposal. That is, extension shifts the production function to the right through more efficient factor-factor combinations. Extension also reduces the costs of information acquisition. Thus it may be considered a low cost input into the production process. It is also a form of education, which improves human capital (Mwakubo 1994).

Table 4.2 Contacts with extension staff

Responses	Machakos		Taita-Taveta		Combined	
	Frequency	%	Frequency	%	Frequency	%
Yes	31	19.9	57	35.6	88	27.8
No	125	80.1	103	64.4	228	72.2
Total	156	100	160	100	316	100

Source: Field survey, 2003

Extension officers are expected to lay out terraces for the farmers as well as encouraging farmers to network so that they can harness collective action. However, it is challenging to improve extension services in the face of dwindling government budgets and reforms that require the public sector to downsize[15] (Omamo 2003).

When farmers were asked whether they thought the extension service is instrumental in soil conservation, a large proportion of farmers did not think so (Table 4.3).

Table 4.3 Farmers' perception of whether or not the extension service enables them to invest in soil conservation measures

Responses	Machakos		Taita-Taveta		Combined	
	Frequency	%	Frequency	%	Frequency	%
Yes	18	11.5	22	14.9	40	13.2
No	138	88.5	126	85.1	264	86.8
Total	156	100	148	100	304	100

Source: Field survey, 2003

These responses depict the farmers' dismal perception of the contribution of extension. It also reflects farmers' low access to extension services, perhaps occasioned by moribund public sector and information systems (Omamo 2003).

Table 4.4 examines farmers' perceptions regarding the importance of social activities (collective action). About 76 percent of the sampled farmers acknowledge the pivotal role of social capital. The rest (about 24 percent) take the other side on this issue—that social capital may have negative externalities such as envy.

[15] Note that there are public sector, voluntary sector (NGOs and churches), and private sector extension services. The first has registered a decline, while the second has witnessed an upswing.

Table 4.4 Farmers' perception of whether or not involvement in social activities has helped farmers

Responses	Machakos		Taita-Taveta		Combined	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Yes	127	88.8	99	63.9	226	75.8
No	16	11.2	56	36.1	72	24.2
Total	143	100	155	100	298	100

Source: Field survey, 2003

Discussions conducted in eight villages in the two districts show substantial differences in social capital. This apparently explains the higher percentage (88.8 percent) of positive response for Machakos, compared with Taita-Taveta (63.9 percent) in Table 4.4. We observed that people in Machakos District were more willing to participate in discussions about various groups existing within their villages. Attendance was quite high, and participants shared foodstuffs such as bread and soft drinks. Moreover, the enumerators engaged in the household survey were often invited for a cup of tea, porridge, or even *githeri*.[16] This was hardly observed in Taita-Taveta District.

4.2 Social capital inventory: A qualitative analysis

In this section, qualitative information on social capital is examined to gain insights into its different dimensions in the study sites, and more important, to relate social capital to outcome variables such as household welfare and poverty and general developmental indicators as perceived by the respondents.

The qualitative analysis centers on three basic indicators of social capital: membership in associations and networks (the structural dimension), trust and adherence to norms (the cognitive dimension), and collective action (the output dimension).

Structural social capital

An important aspect of structural capital is that which relates to empowerment and political action. This refers to the expansion of assets and capabilities of people to participate in, negotiate with, influence, control, and hold the institutions that affect their lives accountable (World Bank 2002). Empowerment occurs as a result of making state institutions more responsive to poor people, removing social barriers, and building social opportunity (World Bank 2000). In the study area, some of the aspects of empowerment and political action considered included participation in elections, petitioning of authorities, information campaigns, protest marches, and communal participatory decision-making processes.

There is an incidental degree of variation in participation in various aspects of empowerment and political participation (Table 4.5). Although more than 80 percent of the respondents participated in the election process, this high participation is likely a result of the anticipated political change in the general elections held in 2002. It is also possible that the local client-patron relationship, particularly in Machakos, could have added to this. The respondents of the two districts acted differently when it came to contacting influential persons or elected representatives. These contacts were more pronounced in Taita-Taveta

[16] This is a meal consisting of boiled beans and maize.

than in Machakos. This is indicative of the unsophisticated social capital structures in Taita-Taveta, which motivates individuals to seek audience with persons they regard as authoritative, instead of meeting with community or village members. In debates on local problems, the residents in Taita-Taveta seem to be more active. This may be indicative of the intensity of the residents concern about problems, compared with Machakos. Alternatively it could mean that Taita-Taveta residents are more empowered to engage in actions on issues that they perceive have a bearing in their development. This is further reflected in the question on individual influence in village decisions, where close to 60 percent of the respondents indicated that they do have some or a lot of influence on decisions involving improvement of their village. Moreover, in Taita-Taveta more than 80 percent of the respondents indicated that the whole village participates in deciding about a community project, compared with 56 percent in Machakos. In general, community participation as a source of development decisions is relatively well developed, which is an indicator of local empowerment. Such a high level of participation could possibly be an outcome of social capital.

Cognitive social capital

Trust and solidarity are proxy variables that can be used to capture cognitive social capital and they are, most likely, self-reinforcing. Trust operates when there is confidence in other agents, despite other uncertainties, risks, and the possibility for them to act opportunistically (Miszta 1996; Gambetta 1988). Trust can come from both generalized norms of morality and more personalized sources embedded in social networks. Regarding trust and solidarity, various aspects can be discerned from Tables 4.6 and 4.7—as measured by the respondents' expectations about and experience with behavior that requires trust.

Most respondents indicated they would render help if a misfortune befell a member of the community. This behavior is more pronounced in Machakos than in Taita-Taveta. Further, the perception of receiving assistance from members of the community or mutual assistance groups, or the family extending assistance to members of the community is more pronounced in Machakos than in Taita-Taveta, with about 89 percent in Machakos and 49 percent in Taita-Taveta expecting support and help from mutual groups.

Table 4.5: Empowerment and political action

Attribute	Responses	Machakos		Taita-Taveta		Combined	
		Frequency	%	Frequency	%	Frequency	%
Voted in election	Yes	131	81.9	137	85.1	268	83.5
	No	29	18.1	23	14.3	52	16.2
	Total	160	100	160	100	320	100
Contacted influential person	Yes	16	10	37	23.0	53	16.5
	No	144	90	124	77.0	268	83.5
	Total	160	100	161	100	321	100
Contacted elected representative	Yes	12	12	19	11.8	31	9.7
	No	148	92.5	142	88.2	290	90.3
	Total	160	100	161	100	321	100
Involved in debate about a local problem	Yes	17	10.6	68	42.2	85	26.5
	No	143	89.4	93	57.8	236	73.5
	Total	160	100	161	100	321	100
Source of decision about a community project	Community leaders	71	44.4	31	19.3	102	31.8
	Whole village	89	55.6	130	80.7	219	68.2
	Total	160	100.0	161	100.0	321	100.0
Perception of whether individual has influence in improving the village	A lot	49	30.6	49	30.4	98	30.5
	Some	76	47.5	46	28.6	122	38.0
	Not very much	18	11.3	57	35.4	75	23.4
	None	17	10.6	9	5.6	26	8.1
	Total	160	100.0	161	100.0	321	100.0

Source: Field survey, 2003

Table 4.6: Readiness to help in case of a misfortune

Source of help	Response	Machakos		Taita-Taveta		Combined	
		Frequency	%	Frequency	%	Frequency	%
Family	Yes	123	76.9	103	64.4	226	70.6
	No	37	23.1	57	35.6	94	29.4
	Total	160	100	160	100	320	100
Mutual groups	Yes	126	78.8	31	19.3	157	48.9
	No	34	21.3	130	80.7	164	51.1
	Total	160	100	161	100	321	100

Source: Field survey, 2003

It appears that the perception of communal trust and honesty is more pronounced in Machakos than in Taita-Taveta (Table 4.7). In Machakos, about 88 percent of the respondents agree or strongly agree that people are honest and trustworthy, compared with 69 percent in Taita-Taveta. When the respondents compare their villagers' members' trustworthiness to those from other villages, their perception becomes muted in both sites. Sixty percent of Machakos respondents agree or strongly agree that people in their village are more trustworthy than people in other villages. In Taita-Taveta, this figure is about 44 percent. In such circumstances, we could expect Machakos to have more cognitive social capital than Taita-Taveta. This result is reinforced by the perception that individuals in Taita-Taveta expect relatively less help from mutual groups than is the case in Machakos (see Table 4.6). Because the employment of trust depends on the probability that agents will behave in a way that is expected (Gambetta 1988), it is likely that Taita-Taveta residents feel that people in their neighborhood behave in unexpected ways or perhaps they perceive trust as enhancing the opportunity for cheating (Granovetter 1985).

Table 4.7: Trust and honesty

Issues	Response	Machakos		Taita-Taveta		Combined	
		Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
People are honest and trustworthy	Strongly agree	39	24.4	34	21.1	73	22.7
	Agree	102	63.8	78	48.4	180	56.1
	Disagree	15	9.4	47	29.2	62	19.3
	Strongly disagree	4	2.5	2	1.2	6	1.9
	Total	160	100	161	100	321	100.0
Members are more trustworthy than in other villages	Strongly agree	19	11.9	18	11.2	37	11.5
	Agree	79	49.4	53	32.9	132	41.1
	Disagree	55	34.4	85	52.8	140	43.6
	Strongly disagree	7	4.4	5	3.1	12	3.7
	Total	160	100.0	161	100.0	321	100.0

Source: Field survey, 2003

Collective action indicators are those that reflect provision of services through joint effort by a group of individuals, so long as this collective action is not imposed by an external force. Since it is internally generated, reaping the benefits of strong social ties—engaging in successful collective action, for example—reinforces the bonds within a group. This leads to further action in the future (Ostrom 1994). Table 4.8 indicates the respondents' perception of the extent to which members of the community can agree to mobilize for a common good in terms of development. In both Machakos and Taita-Taveta districts, 80 percent of the respondents felt that members of their communities can and do contribute, in terms of money and time, to development causes. In Machakos, the majority (about 70 percent) believes that such contributions have remained the same or have improved, compared with other villages, while in Taita-Taveta, the reverse seems to be the case.

Table 4.8: Indicators of collective action: Monetary and time contributions to development

Contri-bution Level	Responses	Machakos		Taita-Taveta		Combined	
		Frequency	%	Frequency	%	Frequency	%
Within village over time	Some or a lot	142	88.8	114	70.8	256	79.8
	Very little or nothing	18	11.3	47	29.2	65	20.2
	Total	160	100.0	161	100.0	321	100.0
Compared with other villages	More	17	10.7	25	15.6	42	13.2
	The same	110	69.2	79	49.4	189	18.9
	Less	32	20.1	56	35.0	88	88
	Total	159	100.0	160	100.0	319	100.0

Source: Field survey, 2003

The extent of social cohesion and inclusion is an important outcome of the presence or absence of social capital. Inclusion is assessed in the context of access to important services, such as education, health, and justice. Exclusion can lead to conflict and even violence. Consequently, the level of sociability can be judged by the perceptions of the respondents regarding the level of conflict and violence within the community. The result of the survey on social cohesion and inclusion perceptions are presented in Table 4.9.

In the table, various factors that would enhance or promote cohesion are presented, namely education, wealth or status of households or individuals, the size of landholdings (which would also be an indicator of wealth, in some instances), social status, gender, age (for example, differences between the youth and the elderly), and the settlement status of an individual or household.

From the results, indicators of social cohesion and inclusion range from a feeling of social unity and togetherness within the community to specific experiences of exclusion. Respondents in Taita-Taveta held the view that indicators such as education, wealth, and landholding tend to widen the gap between community members. Consequently, it would be expected that social cohesion and inclusion would lead to wider variation in the access to such services as education, health, and justice. Further, since the perception of the extent of social cohesion and inclusion is an important positive effect of the presence of social outcomes in the community, one would expect social capital levels to be comparatively less in Taita-Taveta than in Machakos. In general, the perception of social cohesion and inclusion is higher in Machakos than in Taita-Taveta for all key indicators considered. However, when the respondents from the two districts are combined, the relevance of the indicators as sources of noncohesion and exclusion is muted.

Table 4.9: Perception of sources and levels of social cohesion or division

Source of division or cohesion	Response	Machakos		Taita-Taveta		Total	
		Frequency	%	Frequency	%	Frequency	%
Education	Yes	37	23.1	92	57.1	129	40.2
	No	123	76.9	69	42.9	192	59.8
	Total	160	100	161	100	321	100.00
Wealth	Yes	64	40	83	51.6	147	45.8
	No	96	60	78	48.4	174	54.2
	Total	160	100	161	100	321	100.00
Land- holding	Yes	32	20	94	58.4	126	39.3
	No	128	80	67	41.6	195	60.7
	Total	160	100	161	100	321	100
Social status	Yes	27	16.9	77	47.8	104	32.4
	No	133	83.1	84	52.2	217	67.6
	Total	160	100	161	100	321	100
Gender	Yes	19	11.9	73	45.3	92	28.7
	No	141	88.1	88	54.7	229	71.3
	Total	160	100	161	100	321	100
Age	Yes	17	10.6	71	44.1	88	27.4
	No	143	89.4	90	55.9	233	72.6
	Total	160	100	161	100	321	100
Settlement status	Yes	5	3.1	63	39.1	68	21.2
	No	155	96.9	98	60.9	253	78.8
	Total	160	100	161	100	321	100

Source: Field survey, 2003

Location is another important characteristic that influences social capital. To further illustrate the differences in social capital in the two study sites, Table 4.10 shows the averages of the four elements of social capital in the two districts. The results demonstrate that Machakos has significantly higher levels of all the four elements of social capital. That the district also has a significantly higher level of soil conservation investments (that is, terraces) underscores the importance of social capital in harnessing sustainable agriculture in marginal areas.

Table 4.10: Comparison of means of four components of social capital and location

Components of social capital	District	N	Mean	Std. Dev.	F-statistic	t-statistic
MEDENS	Taita-Taveta	161	0.734	0.954	0.877	-4.929***
	Machakos	160	1.244	0.903		
MEDIV	Taita-Taveta	161	6.701	8.780	0.387	-5.445***
	Machakos	160	11.963	8.528		
PARTIC	Taita-Taveta	161	3.441	4.417	0.353	-5.372***
	Machakos	160	6.275	5.018		
COGNIT	Taita-Taveta	161	25.81	2.87	4.462**	-2.849***
	Machakos	160	26.64	2.32		

Source: Estimates from field survey, 2003.
*Significant at P<0.10, ** significant at P<0.05, *** significant at P<0.01.

Focus group discussions reveal that Machakos has more groups in general and many more formalized funeral unions than Taita-Taveta. These unions are formalized, have written by-laws, and are registered with the Department of Culture and Social Services. More than 90 percent of all members of the villages studied belonged to funeral unions. Formation of groups around a significant need such as burying the dead seems to keep the groups active; thus, participation is often high. In addition, sanctions[17] may be meted out for not participating in a group's activities. This includes being required to cover funeral expenses on one's own, in addition to a fine. If there was no suitable punishment for breaking agreements, people would not have the incentive to fulfill them. In addition, the threat of punishment for errant behavior must be credible, or else the threat will have no effect. Since sanctions make it difficult to leave these groups, they tend to remain stable for a long time. However, the ability to impose effective sanctions depends on the extent to which breaches of agreement are observable, which is the case with nonparticipation.

Most groups in Taita-Taveta did not impose sanctions. Perhaps, this explains the low level of social capital in the district. Where compliance rates are low, it may be because many people reciprocate by behaving in an opportunistic way when others are behaving opportunistically. Moreover, even formal funeral unions were not found in Taita-Taveta. The closest example was in Mwakimoi village, which has the Matatitizo ambulance group. One interesting example was seen in Kyamuange village in the Kalama division of Machakos. This village had the highest level of investment in soil conservation, even though the terrain in the village is characterized by steep slopes. A council of elders meets once a week to deliberate on village matters. This council has a management committee that includes the village chairman as a member. All the social networks or groups constantly receive advice and direction from this council of elders. Any conflict between groups can easily be resolved through this body.

[17] Sanctions are essential in order to reign in opportunistic behavior such as free riding and rent seeking.

4.3 Perception of a soil erosion problem

Individuals must perceive negative effects before they can take action to mitigate them. Soil erosion, or soil degradation in general, is a process that takes a long time for the consequences to be realized and, only then, if those affected are able to directly associate the results to that process.

There is an ever growing concern that intertemporal degradation of soil resources is already seriously limiting production in the developing world and that the problem is getting worse (Lal 1990; UNEP 1982; UNCED 1992). It is because of its intertemporal nature that the question arises of whether the immediate users (farmers) are able to recognize the degradation problem early. Yet, because farmers depend on land for their livelihoods, it would be unusual for them to be unaware of serious soil degradation problems, unless they were recent immigrants to a new agro-ecological zone, where the process of degradation has not yet affected yields or its cause is invisible (Scherr 1999).

Soil erosion is one element of soil degradation and is a process that is clearly visible. We should expect, therefore, that farmers' response to soil erosion would be contingent upon their perception of the seriousness of the problem, especially if they perceive a net benefit from introducing ameliorating measures. In Table 4.11, the perception of a soil erosion problem in the two study sites is presented.

Table 4.11 Perception of a soil erosion problem

Response	Machakos		Taita-Taveta		Combined	
	Frequency	%	Frequency	%	Frequency	%
Very high	20	13.2	39	27.1	59	19.9
High	29	19.1	19	13.2	48	16.2
Moderate	40	26.3	48	33.3	88	29.7
Low	47	30.9	27	18.8	74	25.0
None	16	10.5	11	7.6	27	9.1
Total	152	100.0	144	100.0	296	100.0

Source: Field survey, 2003

About 32 percent of the respondents in Machakos rated the seriousness of soil erosion as either high or very high, whereas 26 percent were of the opinion that the problem was moderate, 31 percent thought the problem was small. In contrast, about 40 percent of the respondents in Taita-Taveta felt that the seriousness of soil erosion was either high or very high, 33 percent felt it was moderate, while 26 percent believed erosion was low or that there was no problem at all.

The relatively higher rating of the soil erosion problem in Taita-Taveta may have been the result of a less intensive exposure to soil conservation campaigns than in Machakos. It is possible, therefore, that these campaigns would have enabled Machakos farmers to undertake soil conservation measures more intensively, so that they no longer regarded soil erosion as a serious problem. Nevertheless, 36 percent of the respondents in both districts believed that soil erosion was still a problem, since they rated it either high or very high, whereas 30 percent believed the problem to be of a moderate nature.

5. The influence of social capital on perceptions of soil erosion problems, investments in terraces, and agricultural productivity

In this chapter, we present and discuss the results of the empirical model. The descriptive statistics for explanatory variables are given in Table 5.1. They have been disaggregated for the individual study sites to enable a comparison of the variable mean values, to establish whether there is a significant difference between the two sites.

Inadequate rural infrastructure, which translates to relatively high access costs to input and output markets, imposes significant burdens on cost-minimizing smallholders. Farmers faced with high farm-to-market access costs commit fewer resources to agricultural production (Obare, Omamo, and Williams 2003), resulting in low productivity. In the study areas, relatively high access costs prevailed. The mean differential access cost (*ACESCOS*) of 115 in Machakos and 93 in Taita-Taveta should have a bearing on crop returns in the two study sites, yet mean crop income is not significantly different between the two districts. This could be due to the existing output market structures. Machakos District has access to relatively dense consumption demand sites such as the town of Machakos and even Nairobi, which is not far. In Taita-Taveta, the supply outlets are thin and the nearest high-demand market, Mombasa, is relatively far. Therefore, although Taita-Taveta's access costs may be lower, that advantage is offset by the reduced prices that farmers receive for their products due to a relatively thin market and, thus, lower demand.

Table 5.1. Descriptive statistics for explanatory variables used in empirical analysis

Variable	District	N	Mean	Std. Dev.	Diff. Significant?
ACESCOS	Machakos	155	114.84	24.50	F=36.709***
	Taita-Taveta	160	93.17	40.66	t=-5.709
INC	Machakos	160	64,134.85	178688.89	F=4.994
	Taita-Taveta	161	40,046.58	83046.60	t=-1.467
CROPAC	Machakos	160	16847.85	39512.74	F=0.830
	Taita-Taveta	161	15699.70	29536.19	t=-0.300
LIVESTOCK	Machakos	99	26811.21	33221.15	F=2.744*
WEALTH	Taita-Taveta	151	33312.85	57516.24	t=1.018
DISTH	Machakos	158	357.22	918.92	F=85.888***
	Taita-Taveta	158	2065.98	3630.076	t=5.736***
TERRACES	Machakos	160	926.1328	1267.22	F=0.019
	Taita-Taveta	161	598.51	1994.22	T=-1.755*
HHS	Machakos	160	6.14	2.76	F=0.001
	Taita-Taveta	161	6.38	2.73	t=0.788
FARMSIZE	Machakos	156	1.93	3.39	F=1.533
	Taita-Taveta	161	2.47	3.21	t=1.456
MANURE USE	Machakos	121	1160.33	1921.38	F=5.424**
	Taita-Taveta	45	480.78	887.58	t=-2.282**
FERTUSE	Machakos	53	45.33	69.91	?
	Taita-Taveta	0			
WEALTH	Machakos	160	2.07	1.68	F=3.187*
	Taita-Taveta	161	2.19	2.17	t=0.582
EDUC	Machakos	159	6.79	3.98	F=1.765
	Taita-Taveta	119	7.18	3.70	t=0.834
SLOPE	Machakos	156	2.33	0.87	F=0.521
	Taita-Taveta	157	2.24	0.84	t=-0.904
TENURE	Machakos	155	5.91	1.23	F=22.167***
	Taita-Taveta	161	5.86	0.96	t=-0.441
FARMCA	Machakos	156	0.35	0.57	F=3.134*
	Taita-Taveta	161	0.46	0.66	t=1.639
LABOUR	Machakos	160	156.07	166.38	F=14.049***
	Taita-Taveta	161	235.35	295.10	t=2.962***

*Significant at P<0.10, ** significant at P<0.05, *** significant at P<0.01.

Household incomes are a good indicator of the welfare of the affected households. The mean annual household incomes (*INC*) in the study areas are about Ksh. 64,000 in Machakos and Ksh. 40,000 in Taita-Taveta. The mean income difference appears to be substantial, indicating that the farm households in Machakos are relatively better off than those in Taita-Taveta. Although the income distribution is highly skewed in both districts, the distribution is much worse in Machakos. Skewness encourages the growth of client-patron relationships, which affects the development of social capital.

The mean monetary value of the crop output (*CROPAC*) is not significantly different in the two study sites. Nevertheless, the average values of the crop output from the study sites of Ksh.16,850 in Machakos and Ksh.15,700 in Taita-Taveta are higher than those achieved by the poor households in the Rift Valley Province—the province with the highest mean value of crop production. (Kenya, Republic of 1998). Livestock wealth in the study sites appears to be substantial, though the mean values are not significantly different. On the face of it, the livestock values outweigh crop output values, but these figures could be misleading, especially when considered on an ad hoc basis. If the livestock values were decomposed on an annual basis, it might provide evidence that crop values are still higher.

The mean distance of various plots from the households (*DISTH*) measures 357 meters in Machakos, compared with 2,066 meters in Taita-Taveta, and these mean distances are significantly different. This could be because farm sizes are relatively bigger in Taita-Taveta (approximately 2.5 acres) than in Machakos (approximately 2.0 acres). The mean farm sizes are also significantly different. The average farm size of 2.0 to 2.5 acres compares unfavorably to that of a sample from several districts in the high-potential agricultural areas of Kenya (Jayne et al. 1998), and yet the study sites are located in marginal areas. Since the household sizes are more or less similar, while the mean farm sizes are significantly different at the two sites, it follows, therefore, that the mean per capita farm size (*FARMCA*) is significantly different. The mean values of *FARMCA* indicate that Machakos is more densely populated than Taita-Taveta.

The mean terrace length (*TERRACE*) in Machakos is significantly higher than in Taita-Taveta. This could be for several reasons: First, soil conservation campaigns have been more sustained and intense in Machakos than in Taita-Taveta. Second, the higher income status could have provided an impetus to invest more in terracing. Conversely, it can also be argued that terracing, and hence soil conservation, has enabled farmers in Machakos to improve their incomes from agriculture.

The mean household size (*HHS*) in both sites is six members. The use of manure and fertilizer to condition the soil and the intensity of use is varied, and the mean values are significantly different. For example, while farmers in Machakos use fertilizer (*FERTUSE*) at a mean rate of 45 kilograms per acre, those in Taita-Taveta use none. To find an area in Kenya where fertilizer use in crop production is zero or near zero is surprising. Even where livestock are present, the intensity of manure use in Taita-Taveta, about 480 kilograms per acre is only a third of that used in Machakos (1,160 kilograms per acre. The fertilizer and manure use intensity in Machakos is on average comparable to other areas in the high-potential agricultural regions of Kenya (Obare 2000) and in the rest of Kenya (KARI 1998; Ministry of Agriculture 1989).

The mean value of wealth index (*WEALTH*), farm slope index (*SLOPE*), education level of the household head (*EDUC*), and the land tenure system (*TENURE*) are not significantly different between the two sites. Although these variables are likely to have an effect on soil conservation, it would be difficult to indicate the direction of this effect in the two sites.

5.1. Household perceptions of soil erosion problems in marginal areas

For an individual to make a decision on whether or not to commit resources to mitigate the effects of a given problem, that person must first appreciate the existence of such a problem. And the same individual must then evaluate the severity of the problem and rank it accordingly. In the two study sites, we we presume that the residents recognize that there is a soil erosion problem. Table 5.2 shows the factors that influence the perception of a soil erosion problem in farmers' fields. Five variables are significant for the combined data set: distance to the crop fields from the homestead, wealth, age of household head, household size, and cognitive social capital. The slope variable is only positive and significant for Machakos District. This may be linked to higher education and extension levels in Machakos, compared with Taita-Taveta. In any case, the higher the slope category in Machakos, the higher the probability that a farm household will recognize that they have a soil erosion problem. The combined data set even has an unexpected sign, which perhaps stems from the large data set, which tends to balance off relative effects. Moreover, even the slope index is higher in Machakos, although the differences are not significant.

Table 5.2: Ordered Probit results of perception of a soil erosion problem

	Machakos		Taita-Taveta		Combined	
Variables	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
SLOPE	0.301	3.082***	0.120E-03	0.156	-0.126E-03	-0.207
TENURE	-0.155	-1.934*	-0.512E-01	-0.551	-0.606E-01	-1.196
DISTH	0.288E-04	0.188	0.230E-04	0.628	0.523E-04	1.912*
LCROPAC	-0.412E-05	-1.173	-0.249E-06	-0.071	-0.224E-05	-1.025
EDUC	-0.752E-01	-2.731***	0.249E-04	0.108	-0.304E-04	-0.154
EXT	-0.706E-04	-0.081	0.250E-03	0.001	0.492E-03	0.187
WEALTH	-0.100	-1.294	-0.640E-01	-1.209	-0.718E-01	-2.028**
SEX	0.197	0.406	0.161	0.546	0.113	0.538
AGE	-0.578E-03	-1.275	-0.910E-03	-0.130	-0.826E-03	-1.950*
FAROR	-0.44	-1.437	-0.167E-02	-1.446	-0.114E-02	-1.397
HHS	0.403E-01	0.944	0.629E-01	1.619	0.601E-01	2.246**
FAMCA	-0.145	-1.544	0.218	1.125	0.619E-01	1.214
INC	0.864E-06	1.265	0.294E-06	0.189	0.445E-06	0.942
ACCESCOS	-0.245E-03	-0.468	0.425E-02	1.671*	-0.108E-03	-0.156
ERODE	0.110E-02	0.024	0.170E-03	0.005	0.289E-03	0.115
CWORK	0.462E-03	0.350	0.173E-02	1.703*	0.805E-03	0.997
MEDENS	-0.386E-01	-0.045	1.630	0.899	0.459	0.520
MEDIV	0.154E-01	0.176	-0.134	-0.719	-0.266E-01	-0.301
PARTIC	-0.287E-01	-0.389	-0.552E-01	-0.618	-0.401E-01	-0.859
COGNIT	0.842E-01	4.008***	0.306E-01	1.284	0.574E-01	4.192***
LOC	-	-	-	-	-0.236	-1.405
Log likelihood	-207.174		-205.315		-435.295	
Chi-squared	52.034		20.666		42.331	
N	152		144		296	

*Significant at P<0.10, ** significant at P<0.05, *** significant at P<0.01.

The distance to crop fields is positive and significant for the combined data set. Separately, the variable is positive but not significant. This result is surprising and unexpected. We argued earlier that fields far away would receive less attention from farmers and therefore their perception of a soil erosion problem would be lower. A possible explanation for this state of affairs could be that far-off plots may be more secure and perhaps more fertile, hence the greater concern for those plots. Furthermore, it is likely that farmers in marginal areas encourage plot scattering as a move to reduce income variability and to take advantage of microclimatic variability. Or there is always a possibility that the results are contaminated by unobserved factors such as differences in knowledge, effort, and management skills among households, even in the same village. Pender and Kerr (1996) argue that the impact of many variables is conditioned by the nature of factor markets, the extent of complementarity between those variables and other productive inputs, and the nature of preferences of households. Variables that have no effect on investment, if factor markets are functioning costlessly and perfectly, can have complicated effects if those markets do not function perfectly.

Education level appears to have a significant negative effect in Machakos alone. This strange finding suggests that perhaps the more educated people are, the more likely they are to secure off-farm jobs. This may also help explain the apparently low perception of a soil erosion problem: if income for household subsistence needs is obtained elsewhere, households may pay less attention to the state of their land. Wealth likewise is negative and significant for the combined data set. Again, we can argue that wealthier households may have greater access to livelihood resources and therefore may have a lower perception of a soil erosion problem.[18] In other words, if this argument is valid, then we can say that wealthier households have more survival strategies at their disposal and may not worry about soil erosion problems. An alternative argument would be that the households in Machakos District have already undertaken long-term soil conservation investments to such an extent that they do not perceive erosion as a problem anymore. It is also possible that households with greater wealth may have a lower discount rate and less binding cash constraints and, therefore, do not worry about soil erosion problems.

Extension does not have a significant effect on perception of an erosion problem, although the variable is positive as expected for both Taita-Taveta and the combined data set. As argued earlier, this points to the ineffectiveness of the extension services. Yet, it is the role of extension to diffuse information about soil erosion problems. Perhaps soil erosion is not featured adequately in the extension packages so that households internalize the problem in relation to sustainable agriculture and agricultural productivity.

We find that age is negative and significant. A possible explanation for this is that older people have higher discount rates on new innovations, and therefore they are less likely to perceive a soil erosion problem. Moreover, young farmers are more innovative, are willing to take risks, and have low discount rates for future periods. In addition, they are more likely to be better educated.

Household size is found to have a positive and significant effect on perception. A large household size implies increased food demand or simply increased subsistence needs. These needs are often met by improving the farm's output, which has to start with the appreciation of a soil erosion problem, if it exists. Resources may therefore be shifted toward farm improvements, which is a sure way of meeting the needs of the family. One of these resources is family labor, which often has low transaction costs and is productive. Family labor does not suffer from "principal-agent"problems in which individuals shirk duties for all family members are residual claimants of farm profits (Sadoulet and de Janvry 1995).

Access costs to the market are negative but not significant for both Machakos and the combined data set. Increased access costs to input and output markets are likely to mute the perception of the soil erosion problem if soil productivity has a bearing on market participation. Another possible explanation is that access cost is a proxy for new ideas. As these costs increase, there is likely to be a dearth of new ideas, hence the negative effect on perception. However, for Taita-Taveta, the variable is positive and significant. It might be that, for Taita-Taveta, the higher the cost of access, the more difficult the access. As a result, households become more dependent on the farm for survival and are thus likely to have a higher perception. The same applies to the consumer-worker ratio. The higher the ratio, the higher the subsistence needs of the family; in rural areas these needs are often met through farm production. As expected, cognitive social capital is positive and significant, both for the combined data set and also for Machakos. This suggests that farmers see terracing to reduce soil erosion as an obligation, and exposure to the experiences of neighbors allows households to learn from each other, with the cumulative effect of reinforcing the perception of the soil erosion problem. Farmers believe that one cannot get good yields without terracing. Discussions with extension officers indicate that the perception of a soil erosion problem is ingrained in farmer's minds, and they always feel that they must terrace if they expect to get

[18] It is also possible that they may perceive the erosion problem but rationally decide on an alternative investment portfolio, so that land conservation drops far down in their list of priorities.

good crop yields. As Mwakubo (2003) argues, it is what is expected of a good farmer. There are social benefits or returns from being a good farmer, which is often linked to having a farm with better terraces. Thus, the farmers have internalized specific norms regarding good "farmership." No doubt, norms help to shape preferences and expectations (and thus, behavior),; hence the positive effect on perception of soil erosion. The apparent lack of significance for Taita-Taveta may be linked to the low level of social capital in the district, as shown by the descriptive results, or it may simply be that farmers are not penalized through loss of prestige when they do not have well laid-down terraces. Moreover, focus group discussions show that there are no sanctions on deviant members for nonparticipation in group activities in Taita-Taveta.

5.2 Soil conservation investments in agriculturally marginal and soil erosion-prone areas

Here we consider the responses to soil erosion in the two agriculturally marginal study sites. The response indicator is terrace length. The Tobit regression results presented in Table 5.3 indicate that lagged crop income, density of memberships, membership diversity, cognitive social capital, and location are significant for the combined data set. Land tenure has a negative and significant effect on terracing and also terracing intensity in Machakos. The results show that farms with less tenure are more terraced than the others. This may be due to a statistical anomaly or simply that farmers may try to increase their tenure security through increased investment in soil conservation (Otsuka, Suyato, and Tomich 1997; Matlon 1994).

Table 5.3 Determinants of terracing intensity using a Tobit model

	Machakos		Taita-Taveta		Combined	
Variables	**coefficient**	***t*-statistic**	**Coefficient**	***t*-statistic**	**coefficient**	***t*-statistic**
SLOPE	113.39	1.04	-0.11	-0.05	-0.29	-0.24
TENURE	-2.45	-1.67*	-189.49	-0.60	-1.53	-0.67
DISTH	0.18	1.29	0.195E-01	0.20	0.631E-01	1.15
LCROPAC	0.115E-01	2.91***	-154E-01	1.09	0.125E-01	2.36**
EDUC	0.328	0.22	1.34	1.61	0.52	1.04
EXT	-0.33	-0.36	-1.69	-0.52	-1.04	-0.90
WEALTH	55.26	0.72	-261.54	-1.22	-37.33	-0.42
SEX	-604.13	-1.37	-444.82	-0.57	-391.40	-0.94
AGE	0.46	0.74	74.48	2.97***	0.92	1.00
FAROR	-41.42	-0.14	9.47	0.42	6.44	0.47
HHS	104.98	2.24**	-76.76	-0.51	90.57	1.54
FAMCA	-110.28	-1.01	176.74	0.32	2.69	0.93
INC	-0.608E-03	-0.97	-0.381E-02	-0.92	-0.113E-02	-1.17
ACCESCOS	0.53	0.95	-4.62	-0.54	0.35	0.39
ERODE	-0.475E-01	-0.04	10.97	0.15	1.43	0.80
CWORK	0.36	0.36	1848.07	2.82***	0.40	0.27
MEDENS	1606.28	1.60	4936.16	1.35	3211.43	2.31**
MEDIV	-234.91	-2.38**	-461.43	-1.25	-299.78	-2.15**
PARTIC	83.46	0.97	-70.16	-0.33	-76.78	-0.82
COGNIT	12.45	0.60	-139.46	-1.75*	-45.49	-1.85*
LOC	-	-	-	-	1510.20	4.19***
PERCEP	88.16	0.87	84.59	0.33	105.39	0.90
SIGMA	1290	15.90***	3107	10.83***	2172.37	19.14***
Log likelihood	-1140.66		-651.65		-1842.94	
N	152		144		296	

*Significant at P<0.10, ** significant at P<0.05, *** significant at P<0.01.
Source: Field survey, 2003

Lagged crop income is also positive and significant for Machacos and the combined data set. High crop income implies that more resources will be available to finance both soil conservation investments and other inputs necessary for crop production, so powerful feedback effects are expected. For Taita-Taveta, the variable has a negative sign and is insignificant. This may be linked to the low value of crop output observed in the district.

Household size is positive and significant for Machakos. This suggests, first, that labor is available for terracing purposes. This increases both the probability of terracing and also its intensity, once the decision has been made to terrace. Household size also is a proxy for labor endowment, which is useful for both terracing and crop production, and it should have a positive effect. With regard to household size, two effects occur at the same time but in different directions: consumption requirements increase along with size, which is a negative effect, and the labor endowment also increases, which is a positive effect. The net effect depends on the relative magnitude of these forces. For Taita-Taveta, the positive labor effect appears to be stronger, while the negative effect on consumption prevails in Machakos.

The consumer-worker ratio is positive for the three Tobit equations. It is only significant, however, for Taita-Taveta, where farmers seem to be motivated to improve land productivity through soil conservation investments in order to meet subsistence requirements. Machakos appears to have other sources of income (off-farm) due to its proximity to Nairobi.

Density of membership in groups by households is positive and significant for the combined data set, but looked at separately, the variable is positive but not significant for both districts. This suggests that some characteristics require a large data set for their effects to be realized. However, the sign is as expected. The significant result from the combined data implies that as the density of memberships increase, the likelihood of deciding to terrace and also the intensity of terracing will increase. This suggests that it is the networking that is important. The higher the share of households who participate in groups, the more networking takes place, which is likely to induce a household to decide to terrace or to do more terracing. This suggests that preferences of a community or group play an important role in shaping individual preferences, in particular, if there are social norms as to what constitutes a "good farmer." In other words, membership density appears to work through peer pressure and information diffusion.

The variable reflects the capacity to share information and facilitate the transformation of information into knowledge and action. As membership density increases, a critical level is reached that results in households investing in terraces. If deviation from this norm entails private costs to the farmer—for instance, in the form of social sanctions, guilt feelings, low self-esteem, or loss of prestige—higher investment in soil conservation is plausible. Furthermore, group membership connects a farmer to a variety of people and, thereby, to a wide information base, which may lead to a higher terracing intensity. The converse is true. Moreover, additional group membership from the same household reduces significantly moral hazard and adverse selection problems, because monitoring one another's activities is not costly. We also note that soil conservation (terracing) has positive externalities, which improve soil productivity in the specific area in which such measures are employed but also via improved erosion control over a much wider area. That is, there are spillover benefits to the community as a whole in terms of reduced erosion.

Membership diversity is found to be negative and significant. This is an interesting result, since it implies that the assumption is wrong that an organization with different characteristics—such as age, religion, political affiliation, and occupation—presents greater opportunities for information –sharing. Maybe it is not so much that it is wrong as that greater membership variability creates conflicts and makes it difficult for the group to mesh. As Balland and Platteau (1996) have argued, collective action is successful with homogeneous groups. Participation, the other element of social capital, is not significant. This implies that the extent of participation in decisionmaking does not influence either the decision to terrace or terracing intensity. Cognitive social capital has a negative and significant effect on terracing intensity for the combined data set and separately for Machakos. This element of social capital increases the perception of a soil erosion problem, yet reduces both the likelihood of undertaking a decision to terrace and the terracing intensity. This suggests that cognitive elements (relating to norms, values, attitudes, and beliefs) are acting contrary to expectation. The results also suggest that different elements of social capital do not act in the same direction. We find that group membership or membership density is positive and significant in relation to soil conservation investments. This implies that certain types of social capital suffer from negative productivity, while others enjoy positive productivity (Dasgupta forthcoming).

Location is negative and significant. The results also show that Machakos has a significantly higher level of soil conservation investments than Taita-Taveta. This reflects a greater propensity for Machakos farmers to undertake investments to prevent soil erosion and conserve moisture. This may have to do with learning and copying from neighbours. In Machakos, some of this learning was in the form of an exogenous shock (Tiffen, Mortimore, and Gichuki 1994). In the 1940s, the colonial authorities organized compulsory terracing programs, led by chiefs, government officials, or those whom the government regarded as elders. Most likely, these activities generated new information about the effectiveness of terracing for soil conservation. These activities are likely to have had more impact in Machakos than in Taita-Taveta because Machakos has a higher population density and is closer to Nairobi and to the Kenya highlands.[19] Other exogenous learning shocks were World War I and II, with Akamba soldiers returning home with new ideas from other countries. Terrace construction also started much earlier in Machakos than in Taita-Taveta, so there was more time for the technology to spread from farmer to farmer. This is probably related to the Agriculture and Livestock Development (ALDEV) program of the colonial government to improve agriculture in the ”African reserves.”

Whether the greater intensity of conservation is the result of enhanced conservation ethics of farmers in Machakos or just being closer to Nairobi is a good question. Dietz (2000) posits two causal mechanisms for the latter. First, transport costs for products are lower because the distance to Nairobi is shorter (thus increasing available agricultural income to be used for investment), and proximity to Nairobi increases opportunities for employment and hence remittances that can be used for investments.

Second, it could mean that urban political or cultural influences (state projects, NGO activities, church influence) have more impact. However, the village profiles show that the actual “density” of projects is rather low. Although, there are numerous NGOs in Kenya, their village-level representation is generally low. What matters is the overlap of networks between representatives of these state and nonstate institutions, on the one hand, and villagers, on the other. Many villagers do have profitable contacts with often well-educated ex-villagers in influential positions elsewhere. It seems that the linkages with the cultural elite (church leaders, in particular) are as important as linkages with the political or administrative elite. Moral leadership extends to “good farmership” with a premium on church-mediated social cohesion. Dietz (2000) further suggests that in the adoption of innovations for sustainable land use, it is probably wise to go beyond a technical “diffusion of innovation” approach and accept that it is more about “diffusion of lifestyles” and “moral codes of conduct.” If cultural leaders accept certain practices and if their leadership is acknowledged by many people in a village, the chance that farmers will follow can be expected to be high.

The perception of a soil erosion problem does not necessarily translate into a higher likelihood of increasing investment in soil erosion control through increased terrace intensity or length.

[19] Some areas of Machakos District were part of the so-called “White Highlands” and thus the district received more attention.

5.3: Determinants of soil conservation investments using a 2SLS model

We now move to the results of the 2SLS model[20] presented in Table 5.4. Most of the variables are transformed into natural logs with the exception of the dummy variables. We find that when the data sets are combined, education, sex, and location are significant. None of the variables of the equation for Machakos are significant, whereas for Taita-Taveta, seven variables are significant. These include lagged crop output, education, extension, sex, age, household size, and farm size per capita. None of the variables included to capture social capital are significant in the three equations.

As argued earlier, Machakos has a higher level of terraces than Taita-Taveta. Education is positive and significant both combined and separately for Taita-Taveta. Education is a very important component. Shultz (1964) argues that investment in schooling facilitates the transition from traditional agriculture, which is characterized by low productivity, to modern agriculture where productivity is very high. He further argues that illiteracy does not mean that people are insensitive to the marginal costs and returns in allocating productive factors at their disposal; it nonetheless means that the human agent has fewer capabilities than he would have if he had acquired the skills and useful knowledge associated with schooling.

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[20] Instruments (variables assumed to be correlated with social capital but not with the other regressors) included in the 2SLS regression are length of stay in the village, the influence one has in making the village better, whether people trust each other on matters pertaining to lending and borrowing in the village, whether people in the past joined together to address a common issue, or to petition government officials or political leaders with the goal of solving a village development problem.

Table 5.4. Determinants of soil conservation investments using 2SLS

	Machakos		Taita-Taveta		Combined	
Variables	**coefficient**	***t*-statistic**	**coefficient**	***t*-statistic**	**coefficient**	***t*-statistic**
ln SLOPE	-0.71	-1.57	-0.138E-03	-0.11	-0.302E-02	-0.99
ln TENURE	-0.177E-03	-0.04	0.31	0.85	-0.133E-02	-0.44
ln DISTH	-0.290E-03	-0.11	-0.514E-03	-0.44	-0.469E-03	-0.46
ln LCROPAC	0.19	1.57	0.796E-01	2.06**	0.374E-01	0.69
ln EDUC	0.151E-02	0.83	0.180E-02	5.75***	0.122E-02	2.44**
EXT	-0.219E-02	-1.12	-0.346E-02	-2.13**	-0.293E-02	-1.35
ln WEALTH	-0.828E-01	-0.13	-0.30	-1.61	-0.44	-1.25
SEX	-1.02	-0.22	-0.93	-1.91*	-1.75	-2.23**
ln AGE	-0.569E-03	-0.36	1.16	1.95*	0.157E-03	0.14
FAROR	0.875E-01	0.16	-0.263E-01	-0.45	0.17	1.08
ln HHS	0.79	0.42	1.15	2.75***	0.13	0.18
ln FAMCA	0.71	1.57	0.39	3.97***	0.662E-02	1.27
ln INC	-0.68	-0.50	0.284E-01	0.49	-0.17	-1.06
ln ACCESCOS	-0.232^{E}-03	-0.18	0.21	0.32	-0.133E-02	-0.85
ERODE	0.405E-03	0.14	0.210E-02	1.60	0.686E-03	0.52
ln CWORK	-0.72	-0.31	-0.174E-02	-1.63	0.238E-03	0.15
ln MEDENS	11.55	1.36	1.51	0.23	3.05	0.50
ln MEDIV	-4.25	-0.91	-1.41	-0.27	2.51	0.28
ln PARTIC	-2.33	-0.46	1.41	0.43	-4.94	-0.52
ln COGNIT	5.22	0.90	-1.30	-1.10	2.03	1.54
LOC	-	-	-	-	2.73	4.43***
PERCEP	-0.119E-01	-0.01	-0.13	-0.42	-0.52	-0.95
IMR	3.82	5.77***	3.65	12.364***	3.72	19.83***
N	152		144		296	

*Significant at P<0.10, ** significant at P<0.05, *** significant at P<0.01
Source: Field survey, 2003

Education specifically affects farming in four main ways: first, through the worker effect, whereby a farmer becomes more efficient in performing certain tasks. Second is the allocative effect where farmers learn how to choose optimal resource combinations. In this scenario, the farmer is better able to allocate resources, thus improving investments in soil conservation. Third is the innovative effect. In this, education influences the ability of a farmer to acquire and analyze available information on expected costs and returns, variability, and so forth of innovations, thus reducing time lags in adoption. Finally, there is the market effect where the farmers' capacity to exploit new market opportunities is improved.

Education can also have complex effects, possibly increasing the return to investment or the farmer's access to credit, but also increasing the opportunity costs of the farmer's time (Pender and Kerr 1996). Education provides farmers with information on conservation measures and the effect of soil erosion on productivity. This, in turn, implies that farmers are more likely to incorporate soil conservation into their farming operations.

Education of heads of households is equally important. Education, which is a proxy for information flow, may overcome many characteristics of farmers that act as obstacles to soil conservation, such as unreceptiveness to new ideas, fear of change, and lack of incentives. Education leads to better resource allocation and is a form of human capital

(Shultz 1964; Pudasiani 1983; Welch 1978; and Idachaba 1994). It also improves the farmer's management capabilities (Gould, Saupe, and Klemme 1989). Other studies have also found a positive association between education and adoption of conservation technology (Earle, Rose, and Brownlea 1979; Ervin and Ervin 1982). Thus, a sufficient level of education increases the intensity of soil conservation. In addition to the capital returns generated by education, it also increases participation in social activities, which is a positive externality. . Education is a variable that is within the control of the policymaker. Efforts can thus be made to improve the education standards of farmers, possibly through the extension service and through local NGOs. Training may need to go beyond simple information for the adoption of new practices to include training in farm management—how to run a successful farm operation using the more complex soil conservation practices. The lack of significance of education for Machakos may have to do with the proximity to off-farm jobs in Nairobi. Education increases the opportunity costs of farmer's time by increasing the likelihood of getting a high- paying job if one is available nearby.

Sex is negative and significant for the combined data set and also for Taita-Taveta. This implies that female-headed households invest more in soil conservation than male-headed ones. Bird-David et al. (1998) argue that female-headed households tend to enjoy a broader base of labor division and contribution of resources by members of the household. They also have a greater degree of control over the household resources and feel a greater degree of security. In addition, the authors argue that no significant differences were detected in the extent to which extension agents visited different household types. Nevertheless, Mwakubo (2003) contends that women are exposed to extension services more than men. This is because they are often members of women's groups, while men's groups are rare. Such groups are often the entry points for extension services—the place where extension messages are extended. Extension staff usually participate in public meetings called *barazzas*, which are sponsored by the provincial administration. Women are more likely to attend these meetings than men and to pay more attention to extension messages. Because women are keen to learn and make use of the knowledge gained, they may be better land managers.

Age is positive and significant for Taita-Taveta. The combined data set has the expected sign, although it is not significant. Correlation of age with soil conservation investments possibly shows that terracing is a very expensive undertaking, which older people are more likely to undertake because they have more farming experience[21] and also more accumulated wealth with which to finance terrace construction (Nyang 1999). A bivariate correlation of age of the principal household member and number of rooms (a proxy for wealth) shows that it is positive (0.194) and significant (0.05). But where land markets are absent and poverty is rampant, age raises the time preference (high discount rate) of the poor, which may lower the desire for further conservation (Shiferaw and Holden 1998). Finally, household size and farm size per capita have a positive and significant effect on soil conservation investments in Taita-Taveta. A possible explanation is that the larger the household size, the more abundant the labor available for soil conservation investments. In addition, and more importantly, subsistence needs are rather high, which can be met through increased crop production made possible via increased soil conservation investments. The lack of significance for Machakos may be explained by the availability of other livelihood opportunities, such as off-farm jobs in Nairobi. We are also of the view that there is less land pressure in Taita-Taveta, compared with Machakos. Moreover, this variable (farm size per capita) is expected to be negative.

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[21] This suggests that farmers have to learn about the effects of a new technology before adopting it entirely. This is important if risks of the new technology are unknown and hence there is a need to know its risk profile.

5.3. Social capital, resource use, and agricultural productivity linkages

Table 5.5 presents seemingly unrelated results showing the relationship between social capital, resource use, and agricultural productivity. The resources here are identified as labor and manure. Fertilizer is not taken into account because the amounts used in both Machakos and Taita-Taveta are generally very low. The study results show that none of the farmers in Taita-Taveta use fertilizer, while 33.1 percent of the farmers in Machakos apply fertilizer. We find that membership density does not influence resource use nor agricultural productivity. With membership diversity, the effect is negative and significant, but only when associated with labor use in Taita-Taveta. Internal strife is more likely among diverse groups. Participation in decisionmaking is positive and significant but only with labor use in Taita-Taveta. It is the other element of social capital—cognitive social capital, which is based on solidarity, trust and cooperation—that has predominant effects on resource use and agricultural productivity. Generally, cognitive social capital has positive and significant effects on manure and labor use in both Machakos and Taita-Taveta. The same applies to the combined data set. The only exception, however, is manure use in Taita-Taveta, which is negative but not significant. This could be a statistical anomaly or simply the fact that manure use in Taita-Taveta is extremely low. The study also shows that only 28 percent of the farmers use manure in Taita-Taveta, compared with 76 percent in Machakos. The results are mixed on the influence of cognitive social capital on agricultural productivity. In Machakos, it is negative and significant, whereas in Taita-Taveta, it is positive and significant. With the combined data set, the variable is negative and significant.

Table 5.5 Seemingly unrelated regression results, showing the relationship between social capital, resource use, and agricultural productivity

	Machakos			Taita-Taveta			Combined		
Equations	4a	4b	4c	4a	4b	4c	4a	4b	4c
Variables	*CROPAC*	*LAB*	*MAN*	*CROPAC*	*LAB*	*MAN*	*CROPAC*	*LAB*	*MAN*
TENURE			0.0062 (18.231)***			0.836 (4.517)***			0.0076 (27.185)***
DISTH		0.001 (1.245)	-0.298E-03 (-0.688)		0.001 (1.422)	0.900E-03 (1.393)		0.681E-03 (1.218)	-0.947E-04 (-0.364)
EDUC			-0.938E-04 (-0.645)			0.137E-03 (1.103)			0.107E-04 (0.141)
EXT			0.356E-04 (0.101)			-0.575E-03 (-0.861)			-0.383E-04 (-0.147)
HHS		0.434 (2.128)**			0.300 (2.591)***			0.298 (2.260)**	
INC		-0.795 (-1.264)	0.0629 (1.852)*		-0.329E-04 (-0.067)	0.254E-02 (5.698)***		0.266E-03 (0.475)	0.252E-04 (0.097)
MEDENS	-51.591 (-0.210)	-0.694 (-0.794)	1.643 (0.734)	3.915 (0.616)	0.401 (0.444)	-1.519 (-0.862)	30.041 (0.219)	-0.506 (-0.812)	0.419 (0.290)
MEDIVE	-132.894 (-1.215)	0.573 (1.460)	1.100 (1.106)	-3.505 (-0.991)	-0.876 (-1.727)*	0.739 (0.752)	-91.712 (-1.380)	0.119 (0.393)	0.928 (1.325)
PARTIC	192.338 (1.266)	-0.530 (-0.968)	-2.035 (-1.472)	1.670 (0.423)	0.961 (1.690)*	0.108 (0.099)	84.206 (0.995)	0.310E-01 (0.081)	-1.132 (-1.270)
COGNIT	-200.152 (-10.001)***	1.409 (6.728)***	1.180 (5.924)***	4.538 (12.574)***	1.248 (18.053)**	-0.180 (-1.471)	-48.181 (-5.586)***	1.259 (16.672)***	0.274 (3.338)***
LOC	-	-	-	-	-	-	-319.696 (-10.159)***	-0.141 (-0.979)	3.395 (10.295)***
MANHA	107.676 (57.108)***			3.173 (35.12)***			94.541 (83.958)***		
LABHA	36.690 (7.071)			-2.024 (-11.491)**			16.803 (6.282)***		

Note: Figures in parentheses are *t*-values. *Significant at P<0.10; ** significant at P<0.05; *** significant at P<0.01.
Source: Field survey, 2003

6. Implications for policy and program design and conclusions

In this chapter, policy implications and the program design are discussed in the light of the results obtained in Chapters 4 and 5. The conclusions follow. It can be inferred from the results that program design should be multifaceted. That is, in addition to focusing on soil and water conservation policies, the policy package should consider the potential role of social capital.

6.1 Policy and program design implications

The results of this study show the importance of social capital in soil conservation. This implies that attempting to examine the driving forces behind investments in soil conservation without considering social capital could lead to partial understanding, incorrect conclusions, and wrong policy prescriptions.

Just as good technical design of projects requires a thorough analysis of the physical conditions in which the project will operate, so too does good socioeconomic design require understanding of the institutional context, including social capital. It is important to determine how effective social capital is for sustaining soil conservation. If such programs or designs are to be successful, care should be taken to understand the different forms of social capital and how they can be enhanced and mobilized.. However, it should be kept in mind that these elements are not static; new groups are formed while others become dormant.Policy interventions should be expected to change these patterns. Differences in project performance or success may not only result from differences in agroecological conditions or locations; social capital may also play a role. Social capital formation is linked to differential access to education, credit, markets, time, or labor. Unless these differences are also addressed, increasing investments in soil conservation may not lead to improvements. Projects also need to ensure that there is appropriate infrastructure to support the entry of NGOs and the formation of viable groups.

Approaches to encourage participation are now a part of all soil conservation programs in Kenya. The Ministry of Agriculture trains farmers in soil erosion conservation measures. Following a catchment approach, they promote the creation of village soil conservation committees, which then establish soil conservation structures on farms. Projects and programs must find ways to build up the skills, enthusiasm, and knowledge of farmers. Forcing technologies on farmers without their involvement is likely to fail, even when they are technically appropriate. Farmers often reject such technologies when the external pressure is removed.

If membership density has an observable impact on the adoption of sustainable land management technologies, then there is a case for providing incentives to encourage their development and sustainability. The policy implication, thus, hinges on increasing membership density in the household either by joining existing groups or forming new ones. Given that most groups are limited in membership due to the need for effective management, it is the contention of this study that formation of groups, whether formal or informal, should be facilitated and encouraged. Household members should be encouraged to join existing groups. However, we posit that the size of the group, as focus group discussions revealed, is an important issue. Groups should be small enough to keep transaction and communication costs low, but large enough to cover costs of operation. When starting with a few members, fixed costs of cooperation per member are at their highest and decrease as the number of members increases, which fosters cooperation. Eventually, however, the lower fixed costs per member will be offset by increasing variable costs of cooperation, which increase because of the time needed to coordinate activities, negotiate decisions, agree on procedures for implementation, and monitor and enforce rules.

Groups have become more important as extension service has moved away from a training-and-visit approach to a demand-driven[22] fee-for-service approach. Where poverty prevails, the majority of smallholder farmers cannot afford to pay for extension services. As a result, groups are now becoming entry points for the extension service, because they can reach many farmers at the same time at lower cost. Groups are also invaluable for internalizing the concept of training of trainers. For example, groups or committees can and actually have been trained to lay terraces. These people are then able to lay terraces for others. The same can also be done in other areas or for other services. Also extension messages can easily be passed along in a group setting.

Since soil conservation (terracing) is a form of technology, its adoption can be the result of interactions with government officers, innovations by other farmers, and even information diffusion through social networks. Thus, membership density is crucial. This is because spillover or diffusion effects come into play as members interact with one another. Diffusion of information is often enhanced as membership density increases.

Whereas cognitive social capital raises the perception or awareness of a soil erosion problem, the variable reduces soil conservation investments. The effects on resource use and agricultural productivity are mixed. Since the policy implications for this variable are weak, it seems best to promote or encourage the flourishing of structural social capital.

Membership diversity has a negative effect on soil conservation, whereas participation in decisionmaking seems to have no discernible effect (or it is simply not important). This suggests that policymakers need not worry about participation in decision-making by members of groups. However, there is concern with potentially negative outcomes of membership diversity. This implies that when designing programs, group formation should be encouraged along homogeneous lines.

The policy challenge here is to come up with innovative and cost-effective measures to encourage household membership in groups. One option is to encourage existing groups to remove ceilings on membership, further increasing their membership. However, based on the belief that collective action is more successful with smaller groups (Balland and Platteau 1996), our considered view is that the number of groups should be increased, rather than risking making existing groups too large. New groups are often formed when NGOs move in to new areas. Most set up committees as part of their community mobilization. Not only does operating with groups lower transaction costs, it may also provide contact with potential clients, raise potential economic returns to organizational activities, and potentially reach a greater number of people. Another approach is to keep groups that have already been formed active. Suggestions here include holding periodic seminars on leadership skills, bookkeeping, and project management; widening the income base of groups with the aim of giving periodic substantial dividends to members; and compensating group officials for their time by paying allowances. Once the need that led to the formation of a group is met, it is likely that a group may become inactive. This can be overcome by formulating new goals or objectives around the same membership, such as rotating savings (merry-go-rounds). As Balland and Platteau (1996) argue, if a group is already formed around a common purpose and members share a set of norms and values, the information and coordination costs of organizing them around another purpose will be reduced.

The sources of social capital must also be considered, since they are an important aspect in the conceptualization of any policy program. The family is the first building block in the generation of social capital. Relations within the family foster the development of trust,

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[22] This strategy envisages a market for extension services. However, its efficacy is in doubt given the current experience with agricultural market liberalization under conditions of poor infrastructure, weak institutions, and poverty (Omamo 2003).

essential for the formation of external relationships. Meeting children’s physical and emotional needs influences their perceptions of the trustworthiness of those outside the family and encourages reciprocity and exchange. The implication here is that policies that help maintain the integrity of the family are helpful. Some of these policies are already being pursued by both public and voluntary sector agencies working in the marginal areas. An obvious example here is the NGO-based child sponsorship programs, which are active in the area. At the community level, interactions among neighbors, friends, and groups generate social capital.

Since households overwhelmingly desire help with large expenditures such as funerals, soil and water conservation, and so forth, awareness campaigns could be held as advertisements for groups, so that farmers can see what membership in a group could do for them and therefore choose to become members. There are many ways of increasing social capital. For example, a leaf may be borrowed from Kyamuange village in Kalama division of Machakos district, where social capital was increased by forming a council of elders. The formation of NGOs should be encouraged since, in most cases, they form groups in their area of operation. It is hardly possible nowadays to find a development organization, research organization, or government program that does not attempt to work with community-based operations (CBOs) in the pursuit of rural development goals. This can be done by reducing the registration costs and the length of time it takes to be registered. Hand in hand with this, “NGO bashing” by politicians and government officials should be discouraged. This has a negative effect on the formation of new NGOs and the continued operation of those already formed. The catchment groups originally formed by the extension service to coordinate soil and water conservation efforts in the rural areas need to be revived. In many areas, these have become dormant. These catchment groups receive training from extension on a host of farming-related activities.

Likewise, the Ministry of Culture and Social Services could be in the forefront in the promotion and formation of CBOs. They could initiate advertising campaigns in both the print and electronic media about the benefits of being a member of a group. In addition, the provincial administration could hold public meetings. Another campaign could be spearheaded through churches or mosques, urging members to join groups in their respective villages. Moreover, some activities such as collecting garbage could be undertaken jointly before and after the services for people to network.

Soil conservation issues come in all shapes and sizes and a “one-size-fits-all” policy tool does not exist. Hence, improving agricultural production with preferences for improved environmental quality may require a menu of policy options. But choosing one or many policy tools is just the beginning. How well a policy instrument performs and how the benefits and costs are distributed—among farmers, consumers, and taxpayers—will depend as much on how a policy is designed as on which policy is selected.

Formation of farmers’ field schools should also be encouraged. This type of network and platform provides important opportunities for farmers to learn about and share their experiences regarding integrated soil fertility management, which includes soil conservation structures. Thus, policy initiatives can be designed to reduce or remove potential physical-technical, sociological, or institutional obstacles to local organizations with the purpose of facilitating this process.

Finally, policies to help develop the effectiveness of social capital in the construction of terraces should address ways to effect and maximize benefits from linkages between groups and the state, markets, and civil society; to reduce the costs of group formation, membership, and participation; to access public resources such as the Constituency Development Funds to support viability of groups; and to strengthen the Office of Community Development through training and other facilitation. The latter should serve as the link to the Soil and Water Conservation Branch (of the Ministry of Agriculture), the Provincial Administration, and the National Environmental and Management Authority.

6.2 Conclusions

This study has established that social capital has a significant role to play in soil conservation in marginal areas. Although adoption of soil conservation measures is a decision taken by individual households, the intensity of adoption is considerably enhanced where appropriate forms of social capital are either already in place or are being developed. This is important considering that soil conservation is central to rural development and generally leads to increased incomes, food security, and decreased poverty in marginal areas.

The forms of social capital that are found to be most relevant in the study are density of memberships, membership diversity, participation in decision making, and cognitive social capital. These forms of social capital do not act in the same direction. For instance, membership density is positive with respect to investments in soil conservation, but it has no discernible direct influence on use of resources such as manure and labor or on agricultural productivity. The influence is indirect albeit through soil conservation investments. Whereas cognitive social capital raises the perception or awareness of a soil erosion problem, the variable reduces investments in soil conservation.

Therefore, a number of steps are recommended to increase membership of groups, without undue concern for the participation of members or for making groups heterogeneous. Some of these measures are awareness campaigns, NGO formation, formulation of new goals or objectives for existing groups, and reintroduction of the catchment approach.

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Appendix: Projects Supported Under the Competitive Grants Program

Country	Title	Lead Researcher
	1st Round: 2000-2002	
Kenya	The Effect of Liberalising Trade on Agriculture and Its Implications for Poverty Reduction Efforts in Kenya: A General Equilibrium Analysis	Stephen Njuguna Karingi
Kenya	The Role of Infrastructure and Government Policies in Determining the Efficiency of Kenya's Maize Marketing System in the Post-Liberalization Era	Joseph T. Karugia
Kenya	Animal Health Service Delivery Systems in Kenya's Marginal Areas under Market Liberalization – A Case for Community Based Animal Health Workers	Dr. John Omiti
Uganda	Agricultural Productivity Constraints in Uganda: Implications for Investment	Godfrey Bahiigwa
Uganda	Impact of Rice Production on Food Security and Women in Eastern Uganda	Theodora S. Hyuha
Uganda	The Potential Contribution of Irrigation Technology to the Conservation of Wetlands Bio-Diversity and Enhancement of Agricultural Productivity in Uganda – A Policy Analysis	Ms. Beatrice Okello
Ethiopia	Risk, Consumption Preferences, and Production Choices of Ethiopian Farm Households	Dr. Alemayehu Seyoum Taffesse
Ethiopia	Three Governance Systems in the Kueter Gedera Community Forest: Implications for Sustainable Resource Management and Livelihoods	Tenkir Bonger
Ethiopia	The Performance Of Grain Marketing In Ethiopia: The Case Of The Addis Ababa Central Market	Mulat Demeke Tadelle Ferede
	2nd Round: 2001-2003	
Kenya	Rural Household Transitory Food Insecurity: Bridging Inter-Seasonal Food Gaps Arid And Semi Arid Lands	Milu-Muyanga
Kenya	Effects of Land Tenure on Agricultural Productivity and the Environment A Case Study of Suba and Laikipia Districts	Paul Omondi Obunde
Kenya	Human Population Empowerment & its impact on Food Entitlement Among Vulnerable Groups	Hellen Ommeh
Malawi	Is failure to enforce management regulations really the cause of the decline of Chambo fishery? A policy agenda	Emmanuel Kaunda
Malawi	Analysis Of The Economic And Socio-Demographic Factors Affecting The Demand For Goats And Goat Meat In Malawi	J W Banda
Malawi	The Implications of Land Policy Reform on Tenants in Malawi's Leasehold Estate Sector	Sibonile BANDA
Mozambique	Smallholder Cashew Development Opportunities and Prospects for Food Security and Rural Poverty Alleviation in Mozambique: A policy Perspective	Paulo Mole
Tanzania	The Role Of Micro-Finance Services In Agricultural Sector Development: A Case Study Of Two Regions In Tanzania	Denis Rweyemamu
Uganda	Collective Action In Canal Irrigation Systems Management: The Case Of Doho Rice Scheme In Tororo District, Eastern Uganda	Dick Sserunkuuma Nicholas Ochom
Uganda	Accessibility To Credit By Women In The Ugandan Agricultural Sector	David Muturi Kabiru

Country	Title	Lead Researcher
Uganda	Institutional arrangements for provision of Market infrastructure resources in Uganda’s Horticultural industry: Implications for female farmers and exporters with limited resources	Hannington Sengendo
Uganda	The Role of Home gardens in ensuring Nutritional Security in Rural and Urban Areas of Uganda	Mbogha Ngelese Johnson
	3rd Round: 2002-04	
Malawi	Analysis of Gender Roles in Livestock Production for Smallholder Crop/Livestock Farming Systems in Malawi	Fanny Chilera
Kenya	Effects of HIV/AIDS on Agricultural Production and Rural Livelihoods in Kenya: A Case Study of Eastern Province	Lydia Ndirangu
Kenya	The Influence of Social Capital on Sustainable Agriculture in Marginal Areas, Kenya: A Case Study of Machakos and Taita-Taveta Districts	Samuel Mwakubo
Ethiopia	Post-Harvest Grain Management Practices and Food Security in Ethiopia: Farmers’ Perception of Risk, Post-Harvest Management Choices and Its Impacts on Household Food Security	Abebe Gabriel
Uganda	Business Skills and the Entrepreneurial Success of Rural Women in Commercial Agriculture: A Case of Mukono, Mpigi and Wakiso Districts [Uganda]	Warren Byabashija
Ethiopia	Demystifying Urban Agriculture: Status Analysis and Policy Implications for Urban Livelihood and Food Security, The Case of Addis Ababa City, Ethiopia	Solomon Fisseha
Tanzania	The Effects of Social Capital on Food Security/Insecurity in Rural Communities in Tanzania	Jeremia Makindara
Uganda	Malnutrition in the Face of Plenty: An Assessment of the Factors Responsible for High Levels of Childhood Malnutrition in the Western Region of Uganda: A Case of Bushenyi District	Joyce Kikafunda
Malawi	The Socio-Economic Impact of Treadle Pumps in Smallholder Irrigated Agriculture in Malawi	Munday Makoko

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