

**EPTD WORKSHOP SUMMARY PAPER NO. 9**

**POLICIES FOR SUSTAINABLE LAND MANAGEMENT IN THE  
HIGHLANDS OF ETHIOPIA**

**Edited by**

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**Summary of Papers and Proceedings of a Workshop held at  
The International Livestock Research Institute  
Addis Ababa, Ethiopia, 22-23 May 2000**

**Environment and Production Technology Division  
International Food Policy Research Institute (IFPRI)  
2033 K Street, N.W.  
Washington, D.C. 20006**

**Workshop Co-hosted by  
International Livestock Research Institute, (ILRI)**

**October 2000**

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

*This paper is also being published by the International Livestock Research Institute as ILRI Socioeconomics and Policy Research Working Paper No. 30.*

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## 1. THE OPENING CEREMONY

*Welcome by Simeon Ehu, International Livestock Research Institute.*

Your Excellency, Ato Belay Ejigu, Vice Minister of Agriculture of the Democratic Republic of Ethiopia; Prof. Mitiku Haile, President, Mekelle University; Distinguished Representatives of the Regional Governments of Amhara, Oromiya and Tigray; and Friends and Colleagues.

On behalf of the Director General and the staff of the International Livestock Research Institute (ILRI) it gives me a great pleasure to welcome you to ILRI for the workshop on “Policies for Sustainable Land Management in the Highlands of Ethiopia”. This project is a joint activity between the International Food Policy Research Institute (IFPRI) and ILRI in collaboration with Mekelle University, the Bureaus of Agriculture of the Amhara and Oromiya National Regional Governments as well as the Ethiopian Agricultural Research Organization (EARO) and the Agricultural University of Norway. Thus I would like to welcome especially Dr. Peter Hazell, Director of the Environment and Production Technology Division of IFPRI, the Division responsible for this project at IFPRI. Many of you know Dr. John Pender, the IFPRI Scientist in charge of implementing the project. I would like to welcome Dr. Belay Demissie, Head of the Bureau of Agriculture of the Amhara National Regional State, Ato Kasso Morka, Deputy Head of the Oromiya Agricultural Development Bureau, and Prof. Mitiku Haile, President of Mekelle University. At this moment, I would like to congratulate Professor Mitiku for successfully leading Mekelle University College into a full University and for being its first President. ILRI and IFPRI were very pleased to be part of the inauguration ceremony that took place

earlier this month in Mekelle. Also I would like to thank especially the participants from Tigray and the Amhara Regions, who traveled long distances by bus to attend this workshop and also participants from distant places in Oromiya. This shows the level of commitment that you all have in this work. Welcome also to Dr. Stein Holden and Dr. Bekele Shiferaw of the Agricultural University of Norway.

As many of you know, ILRI is one of the 16 Centers supported by the Consultative Group on International Agricultural Research (CGIAR), a consortium of more than 55 member nations, foundations and donor agencies supporting international agricultural research to address poverty alleviation, food security and environmental protection. The CGIAR sponsors are the World Bank, FAO, UNDP and UNEP. ILRI's mission is to help reduce poverty, hunger and environmental degradation through livestock research to enhance productivity and sustainability of agricultural systems in the developing world.

ILRI has a global mandate for international livestock research. Our principal activity continues to focus on sub-Saharan Africa. A major part of ILRI research is development-oriented and is conducted in collaboration with partners from national and international research organizations. ILRI research spans the spectrum from biological research on cattle, sheep and goats to assessing the social, economic and environmental impact of livestock production to economic analysis providing information for policy makers.

Recently ILRI re-organized its research into eight major programs and four production-to-consumption projects to address the multiple challenges those development poses to research. These programs are:

1. Systems Analysis and Impact Assessment
2. Livestock Feeds and Nutrition
3. Livestock Health Improvement
4. Livestock Genetics and Genomics
5. People, Livestock and Environment
6. Livestock Policy Analysis
7. Strengthening Partnership for Livestock Research
8. System Wide Livestock Programme

The Production-to-Consumption projects include:

1. Market-oriented Smallholder Dairy
2. Market-oriented Livestock Systems in West Africa
3. Crop-livestock Systems in Mountain Regions
4. Crop-livestock Systems in Rainfed Lowland Regions in Southeast Asia

The goal of the Policy Programme of ILRI which I have the honor and privilege to co-ordinate is to provide information on the impact and consequences of government policies affecting the livestock sector with a view to determine better policy options to alleviate poverty, improve food security and promote sustainable use of natural resources in developing countries. The outputs we expect to produce include:

- Increased knowledge on policy options and strategies to enhance technology adoption
- Policy options to promote smallholder participation in livestock markets
- Policy options and institutional options to reduce environmental effects of livestock production

- Methods, models, and databases
- Capacity strengthening in policy analysis

We work in partnership with many institutions. But the most prominent in the CGIAR is the IFPRI whose mission is to identify and analyze alternative national and international policies for meeting food security and nutritional needs as well as making the results available to policy makers. Our joint project on “Policies for Sustainable Land Management in the Highlands of Ethiopia” is a principal activity in which ILRI and IFPRI collaborate strongly.

The issues we are addressing in the joint project are timely because like the rest of the countries in the East African Highlands, the highlands of Ethiopia are characterized by low agricultural productivity, poverty and land degradation. Grain yields are less than 2 tons per hectare and a large proportion of the rural population live in absolute poverty. The highlands of Ethiopia are also characterized by severe land degradation where mining soil nutrients and soil erosion are the major problems. We are aware that technical solutions to these problems are being researched. Many potential technologies have been identified. However, it is not clear that these technologies are applicable everywhere. Socio-economic and policy research is needed to identify the socio-economic and policy factors that prevent on-farm adoption of sustainable practices. Some of the socio-economic policies include issues such as land tenure, land/forest use regulations, infrastructure development, market liberalization and input supply policies to name but a few.

To address these problems, a Regional (East Africa) workshop was organized during February 1997. This was followed by 3 workshops: one in Tigray (in March

1997), one in Amhara and one in Oromiya in October and November 1998, respectively. These workshops led to the development of proposals that were funded principally by the governments of Norway and Switzerland. We are also using support from USAID and are still looking for funding to support additional activities in the Oromiya region. I am especially pleased that Dr. Mauro Ghirotti of Italian Development Cooperation is participating in this meeting as we are negotiating possible funding from them. We thank all the donors for the continuing support to CGIAR research for development.

The research began in Tigray in January 1998, in Amhara in March 1999 and in Oromiya in a limited way in April 1999. Significant progress has been accomplished to date in each of these regions.

The objectives of this workshop are to:

- Familiarize key policy makers and other stakeholders in Ethiopia with the objectives and activities of the project;
- Review the progress and findings of the project so far; and
- Consider key policy issues affecting the prospects for sustainable land management in the highlands of Ethiopia.

Dr John Pender will elaborate these objectives later. I would like to thank you for your attention.

*Welcome by Peter Hazell, International Food Policy Research Institute.*

Honorable Vice Minister, Friends and colleagues, on behalf of IFPRI, I warmly welcome you all to this conference.

Within the CGIAR system, IFPRI's mandate is to identify and analyse policies for meeting food security on a sustainable basis, with particular regard to reducing poverty and ensuring sound management of the natural resource base; to make the results of such research widely available to policy makers and others in a position to use them; and to help strengthen the capacity of institutions in developing countries to conduct and apply the results of food policy research. IFPRI pursues this mandate through research conducted in the areas of trade and macroeconomic policies, markets and structural studies, food consumption and nutrition, and environment and production technology. This work is conducted in a large number of developing countries throughout the world, in collaboration with national and international partners such as are represented at this conference.

This project on Policies for Sustainable Land Management in the East African Highlands is an activity of the Environment and Production Technology Division of IFPRI. We appreciate the partnerships with ILRI, Mekelle University, the Bureaus of Agriculture and Planning from several regions, and the Ethiopian Agricultural Research Organisation in implementing this research project. I hope that the participation of all of those present at the conference will help us understand the land degradation problems and potential solutions better. We are looking forward for a fruitful discussion.

*Opening address by Belay Ejigu, Vice-Minister, Ministry of Agriculture, Government of the Peoples Democratic Republic of Ethiopia*

Distinguished guests; Seminar participants; Ladies and gentlemen. It gives me a great pleasure and honor to be with you here for this important national seminar on "Policies for Sustainable Land Management in the Highlands of Ethiopia".

As part of a series of workshops on policies for land management, it is my understanding that this seminar aims to review results and findings of on going and completed related research activities.

Making use of this ideal forum, we can look into policy and institutional constraints to sustained development in the Ethiopian highlands which are, in large part, dissected and predominantly sloping and which include approximately 85-90 percent of Ethiopia's farmers, over 95 percent of the cropped area, around two-thirds of its livestock, almost half of its land area and over 90 percent of the national economic activity. However, these areas of great magnitude are seriously threatened by various constraints such as limited infrastructure development, limited competition in input supply markets and their impact on soil erosion.

Soil erosion is a severe problem in sloping areas, especially in the northern and central highlands where vegetative cover is very low and soils are already very shallow. Erosion is most severe on cultivated lands, average 42 tons per hectare per year on currently cultivated lands and 70 tons per hectare per year on formerly cultivated degraded lands.

Land degradation could indeed be a potentially serious threat to food production and rural livelihood by the year 2020, particularly in more densely populated pockets of

rural poverty. Further expansion of cultivation into areas of fragile soils or critical habitats for biodiversity preservation can lead to significant environmental deterioration unless carefully managed.

Although technical solutions are being developed to arrest soil degradation, we believe that appropriate policy greatly contributes to combat soil erosion and degradation in general.

Seminar participants; Ladies and gentlemen. Secure property rights and rights of access to natural resources are essential for long-term investment by farmers in land conservation and improvement as well as to enable farmers or communities to negotiate in the development of management plans.

Protection of grazing areas for herders is an emerging issue where crop production is expanding into traditional grazing areas. Insecure access and property rights for women farmers is an important problem, particularly in areas where women are the principal land managers by tradition or due to migration by men.

Coming to the Ethiopian situation, under the new Ethiopian constitution, all land is property of the state, and it may not be sold or mortgaged. The rights of peasants and pastoralists of free access to land are guaranteed. The constitution also guarantees the rights of individual to improvements they make to land, including the right to bequeath, transfer, remove or claim compensation for such improvements if the right to use expires.

With regard to the scarcity of land, measures are being taken to involve farmers with very smallholdings to participate in various income-generating schemes in the rural areas. Besides, in order to ensure the land tenure security of the rural community, efforts are being made to issue land title certificates.

Seminar Participants; Ladies and gentlemen. At this juncture, I would like to seize this opportunity to recommend this august body to look for ways and means to find out investment opportunities to increase capacity of the research and extension system and the need for greater integration of productive technologies with efforts to conserve soil and water and to assess the effects of different policy and institutional interventions on land management and also to build local capacity for policy analysis particularly in the area of land management.

As you gather together in this important forum, I trust you will address all these very important issues during your deliberations; discuss and consider key policy issues, which will lead to the prospects for sustainable land management in the highlands of Ethiopia.

I look forward to the outcome of this seminar as I am optimistic that it will contribute to our efforts to the formulation of policies for sustainable land management in the highlands of Ethiopia which I believe can be achieved by working together with international institutes such as the International Livestock Research Institute and the International Food Policy Research Institute with which we continue to have very positive relations. I believe that working at the regional level by using all resources available will be mutually beneficial.

I wish you will success and now declare the seminar open. Thank you!

## **2. POLICIES FOR SUSTAINABLE LAND MANAGEMENT IN THE ETHIOPIAN HIGHLANDS: PROJECT OBJECTIVES, ACTIVITIES AND ORGANIZATION**

John Pender  
International Food Policy Research Institute

### **MOTIVATION FOR PROJECT**

- Severe interrelated problems of low agricultural productivity, land degradation and poverty in the Ethiopian highlands
- Cereal yields less than one ton/ha common
- Evidence of severe soil erosion and soil nutrient depletion
- Most farmers surviving with less than one ha of land and incomes less than \$1 per day
- Large public and private investments (infrastructure, research and extension, education, conservation measures, etc.) being made to address problems
- Although proximate causes of problems known, underlying factors and impacts of policies not well understood

### **GENESIS OF PROJECT**

- Initial planning (1996-98)
  - Literature review, consultations, field visits
  - Participatory planning workshops
- National workshop – November 1996
- East African regional workshop – February 1997

- Workshops in Tigray, Amhara, Oromiya – 1997 and 1998
  - Key problem areas identified – soil erosion, soil fertility depletion, overgrazing, deforestation
  - Key policy issues identified – impacts of land policies, market policies, infrastructure, research, extension, conservation measures, decentralization/governance
- Initiation of project – late 1997 (Tigray) and late 1998 (Amhara and Oromiya)

## OBJECTIVES

- To improve understanding of land degradation and its causes in the Ethiopian highlands
- To identify major pathways of development in the highlands, their causes, and implications
- To identify and assess policies and strategies to facilitate more productive, sustainable, and poverty-reducing pathways of development
- To increase awareness of land degradation problems and strategies to promote more productive and sustainable land management
- To strengthen the capacity to conduct socioeconomic and policy research related to sustainable land management in the region

## ACTIVITIES

- *Problem characterization and generation of hypotheses* – literature review, consultations, field visits, secondary data

- Identification of development pathways and land management practices, their causes and implications – community, household and plot-level surveys
- Assessment of policy, institutional and technology options to improve land management – analysis of surveys and bio-economic models
- Outreach activities including policy workshops, dissemination of papers and policy briefs, National Advisory Committee
- Capacity-strengthening activities including involvement of collaborators in research and publications, support to Ethiopian graduate students, training workshops, etc.

## ORGANIZATION

- Overall project leadership and coordination – IFPRI and ILRI
- Tigray
  - Leadership – IFPRI, ILRI, Mekelle University
  - Collaborators – Tigray Bureau of Agriculture and Natural Resources, Tigray Bureau of Planning and Economic Development, others
- Amhara
  - Leadership – IFPRI, ILRI, Amhara National Regional Bureau of Agriculture and Natural Resources, Agricultural University of Norway
  - Collaborators – Amhara National Regional Bureau of Planning and Economic Development, others
- Oromiya

- Leadership – IFPRI, ILRI, Oromiya Agricultural Development Bureau,  
Ethiopian Agricultural Research Organisation, Purdue University,  
Manchester University
- Linkages to other international research programs and similar IFPRI-led  
research in Uganda
  - African Highlands Initiative
  - Soil, Water and Nutrient Management Programme
  - ASARECA/ECAPAPA
  - IFPRI 2020 Vision Policy Research Network for East Africa
  - Financial support – Switzerland, Norway, Italy, U.S.A, IFPRI and ILRI  
core resources

### 3. SUMMARY OF WORKSHOP PAPERS AND DISCUSSIONS

John Pender<sup>a</sup> and Simeon Ehui<sup>b</sup>

<sup>a</sup>International Food Policy Research Institute

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#### OVERVIEW OF PAPERS

The papers presented at the workshop provided a great deal of information about the interrelated problems of land degradation, low agricultural productivity and poverty in the Ethiopian highlands (emphasizing the administrative regions of Tigray, Amhara and Oromiya); the proximate and underlying causes of those problems; the responses of individuals, communities and governments to the problems; the impacts of some of those responses; and the constraints and opportunities affecting the potential for more productive, sustainable and poverty-reducing development pathways in the Ethiopian highlands in the future.

The major land degradation problems in all regions include soil erosion and soil nutrient and organic matter depletion (Fitsum et al.; Lakew et al.; Bezuayehu et al.). The proximate causes of these problems include soil characteristics (such as its inherent erodibility and fertility), intense and erosive rainfall periods, the steep and dissected terrain in the highlands, deforestation, overgrazing, cultivation on steep slopes, frequent plowing, limited adoption of soil and water conservation measures (especially outside of Tigray), declining use of fallow, burning of dung and crop residues, feeding of crop residues, soil burning, and limited application of organic or inorganic fertilizers. Many

factors are hypothesized as underlying causes of these problems, including population pressure, poverty, limited market development, limited market access, land tenure insecurity and land fragmentation, lack of credit, short term perspective of farmers, unavailability of appropriate and profitable technologies or inputs, farmers' lack of awareness of such technologies, farmers' attitudes, high costs of inputs, external costs or benefits of land management that individual farmers fail to take into account, and difficulties in achieving effective collective action to manage resources, among others. Many policy arenas can affect these factors in complex ways, including family planning policies, market liberalization, land policies, infrastructure investment (especially in roads and irrigation systems), agricultural research and extension policies, resource conservation programs and policies, input and credit supply policies, education policies, and policies to promote decentralization and development of local organizations.

The challenge for policy makers is to identify and implement appropriate combinations and sequences of policies and programs to effectively address the problems and achieve the development potential of the Ethiopian highlands in a sustainable manner. It is unlikely that a one-size-fits-all set of policies will work in all circumstances. Although policies cannot be tailored to suit every possible situation, it may be useful to consider what "development pathways" have comparative advantage in different types of situations. The main factors determining comparative advantage of different development pathways likely include agricultural potential, market access, and population density. For example, intensification of cereals production using high levels of external inputs and expansion of perishable cash crops are two development pathways that likely have strong potential in areas with high agricultural potential (or irrigation)

and high market access; whereas in lower potential areas further from markets and low population density an appropriate development pathway may be to increase the productivity of the mixed crop-livestock system by improved management of grazing lands and woodlots and integrated soil nutrient management on cultivated land. These development pathways may be interdependent (e.g., intensified and more productive cereal crop production may enable farmers to devote more land and resources to perishable cash crops). The policy requisites for different development pathways may differ (e.g., input supply and credit will be critical for high external input oriented pathways, while improved institutions for managing communal grazing lands and woodlots may be critical to increasing productivity of mixed crop-livestock systems in more remote areas).

The policies of the national and regional governments in Ethiopia have emphasized conservation based agriculture led industrialization, through liberalization of markets; decentralization of planning and resource management; widespread investments in improved infrastructure, education, health facilities and other public services; emphasizing community resource conservation and management through establishment of community woodlots and enclosed areas; promoting private adoption of resource conservation measures; promoting use of improved agricultural inputs, such as improved seeds and fertilizer and availability of short-term agricultural credit; and promoting development of farmer organizations and other local organizations. Evidence on the impacts of these policies and other factors on land management and implications for agricultural productivity, natural resource conditions and poverty is still scarce, though

some useful evidence was provided by the papers presented in the workshop, particularly for Tigray (where the research project is most advanced).

Based on analysis of the Tigray community survey, Pender, Jagger and Berhanu found that there has been broad improvement in access to infrastructure and public services (e.g., roads, irrigation, schools, health facilities, extension service, credit) in the Tigray region since 1991, though many communities are still lacking in access. There has been widespread adoption of resource conservation measures by communities and households, as well as adoption of modern agricultural inputs (especially fertilizer, vaccines and improved seeds). These investments have contributed to perceived improvements in many measures of human welfare and natural resource conditions. However, commensurate improvements in yields were not observed in the community survey. This could be due to problems in obtaining reliable yield data in the community survey or poor yields in the particular year for which recent yield data were collected (1998), but it could also be an indication that uncertain rainfall and/or land degradation are limiting crop yield improvement, despite investments and adoption of new technologies. Consistent with the latter interpretation, the authors also found that food availability was declining in many communities. Declining availability of grazing land and fuelwood are also important resource concerns in Tigray.

There are significant differences in land management practices and their implications across communities in Tigray, and these were found to relate to differences in livelihood strategies, agricultural potential, access to infrastructure, technical assistance, population pressure, education, and other factors. Cereal crop production is the dominant livelihood strategy in all communities surveyed in Tigray, but communities

where non-farm employment was the secondary activity of men performed better than other communities in terms of several indicators of productivity, resource and welfare improvement. Perishable annual crop production was also associated with improvement in some resource conditions, compared to areas where livestock production was the secondary activity. These livelihood strategies thus offer potential as pathways of more sustainable development. Both of these strategies are strongly associated with the presence of irrigation and with proximity to Mekelle, the largest market in Tigray. Thus irrigation investment and market development may help to stimulate sustainable development pathways in the region.

Although irrigation development was found to contribute to some livelihood strategies, it did not lead to as much adoption of improved technologies, increases in yields or welfare indicators as might be expected (controlling for livelihood strategies). Many farmers continue to use traditional technologies even when irrigation is available, limiting the productivity impact of irrigation (Girmay et al.). Some indicators of human welfare, including food availability and child mortality, were more likely to worsen where modern irrigation development was occurring, suggesting that irrigation may be promoting changes in crop production that are reducing food security. These results are not conclusive, but suggest that more research on the impacts of irrigation investments in Tigray, and possibly policy interventions to increase the returns and ameliorate the negative impacts, are needed. Research and policies on the institutional requirements of irrigation projects (e.g., clarifying water rights and responsibilities for cost sharing and maintenance) are also needed (Ibid.).

Road development has also contributed to changes in farming systems, shifting production away from cattle and towards cash crops (Pender et al.). It is associated with reduced burning of dung fuel, increased yields and food availability, and improvement in the quality of grazing land and water. By contrast, proximity to towns had more negative impacts on several indicators of resource management and resource conditions, suggesting that priority should be given to addressing resource degradation problems in areas close to towns, where there are greater demands on resources. Proximity to town is also associated with less effective collective action in managing community woodlots (Berhanu et al. paper on woodlots) but with mixed effects on collective action to manage grazing lands (Berhanu et al. paper on grazing lands).

The extension and credit program of the Tigray Bureau of Agriculture and Natural Resources appears to have effectively promoted adoption of more productive and soil conserving land management practices, contributing to higher crop yields, increased food availability and household wealth. However, the program is associated with degradation of grazing lands, probably because it has contributed to increased oxen ownership. Thus options to improve management of grazing lands should be considered as a priority by the Bureau.

Population pressure has been associated with adoption of several measures of labor and capital intensification of agriculture in Tigray (Pender et al.). However, it is not associated with increased crop yields (as one would expect), suggesting that cropland degradation has resulted from population pressure. Perceived decreases in the quality of grazing land are also associated with population pressure (*Ibid.*). This is consistent with the finding of Berhanu et al. (grazing land paper) that violations of use restrictions on

grazing land were more common at high (greater than 200 persons/km<sup>2</sup>) than at intermediate (between 100 and 200 persons/km<sup>2</sup>) population densities. Collective action in managing community woodlots was also found to be more effective at intermediate population density (Berhanu et al. woodlot paper).

Collective action to manage woodlots was found to be less effective for woodlots that were promoted by an external organization (usually the Bureau of Agriculture), suggesting the potential for undermining collective action by external intervention and the need for greater local participation in decisions about community woodlots (Ibid.). Communities in Tigray generally believe that they are not yet allowed to harvest trees from their woodlots, and this may undermine incentives of people to contribute to collective action to manage these woodlots, especially if the woodlot is viewed as having been promoted by an outside organization. There appears to be a lack of clarity about the policies in Tigray regarding if and when communities are allowed to harvest trees from woodlots, and how the benefits should be distributed (this point was acknowledged by officials from Tigray in the discussion, who indicated that the policies are being developed). Clarification of these policies by the Bureau of Agriculture and Natural Resources may increase the benefits received by communities from these resources and the incentive of communities to manage them effectively. It may be most effective to devolve these decisions to the *tabia* or village level (Jagger and Pender).

Another current policy issue related to tree management in Tigray is whether to allow or promote private tree planting (or other conserving uses) on degraded lands. A policy on this issue has been enacted in the Amhara region (Lakew et al.), but this is still being studied in Tigray (though it is being pursued on a pilot-scale basis in Tigray).

Evidence from the Tigray community survey, which shows high survival rates of trees on such private woodlots where this has been tried, suggests potentially very large economic returns from expansion of this approach (Jagger and Pender). However, there are ecological concerns about increased private tree planting—particularly given the preference of households for eucalyptus—due to potential negative effects of eucalyptus on nearby crop production (via competition for water, nutrients, sunlight, and allelopathic effects of eucalyptus leaves). Available evidence suggests that such negative impacts can be minimized by careful placement of private or community woodlots, and that there are numerous potential ecological benefits of tree planting as well (e.g., uptake of water runoff, reduced mass wasting of slopes, reduced wind erosion, reduced burning of dung and crop residues due to increased fuelwood availability). Given the potentially large benefits and limited alternative development opportunities in Tigray, serious consideration should be given to allowing/promoting expanded private tree planting on degraded lands.

Evidence on the impacts of policies and other factors on land management in the other regions (Amhara and Oromiya) are more limited at present, since the surveys have not been completed yet there. In much of Amhara (especially the lower rainfall areas in the north and east of the region), many conditions are similar to those in much of Tigray (e.g., low and uncertain rainfall, high population pressure, thin and degraded soils, etc.), and most of the policies being pursued are similar to those in Tigray (Lakew et al.; Fitsum et al.). Thus we expect similar responses and implications from these areas, though this hypothesis cannot be tested until the data from the Amhara survey are analyzed.

Data from one village in the lower potential part of southeastern Amhara (Andit Tid, which represents a situation of high market access, high population density and low agricultural potential) indicate that a downward spiral of declining farm size, land degradation, reduced crop yields, and increasing poverty is occurring (Holden and Shiferaw). This spiral is being driven by population growth, and is occurring despite the fact that this village has good access to roads and markets and that there has been a long-term effort to promote sustainable land management practices in this village through the Soil Conservation Research Project (SCRIP). Thus reliance on market forces alone or heavy emphasis on soil conservation technologies appears insufficient to achieve sustainable land management in such a highly degraded area. Part of the problem is that the soil conservation technologies that have been promoted reduce farmers' crop output and incomes for several years (since they reduce cropped area), making them unattractive, especially to poorer farmers who have access to very little land and may have a short-term perspective. The top-down approach to promoting soil conservation technologies in this village likely contributed to this problem, though it is not clear whether a participatory approach could have been more successful if more suitable technologies are not available. Other factors that also appear to contribute to the poor performance of agriculture in this village include imperfections in the markets for land and oxen, and land tenure insecurity caused by the expectation of land redistribution. Policies that attack the multiple constraints to more profitable and sustainable land management are needed, and may include approaches that interlink different constraints and policies. For example, increased tenure security could be linked to farmers' soil and

water conservation efforts on the land, giving them greater incentive to undertake and maintain such investments.

In much of western Amhara and Oromiya, agricultural potential is much higher and land is not as degraded as it is in Tigray and eastern Amhara (Lakew et al.; Bezuayehu et al.). Detailed data collection and bioeconomic modeling work completed in the Ginchi microwatershed in Oromiya (a community with high market access, high population density, and relatively high agricultural potential, though with problems associated with Vertisols in the valley and shallow soils on the steep slopes) indicate that substantial land degradation is occurring in this village (Okumu et al.). Continuation of limited technological intervention in the village is predicted to result in continuing problems of soil erosion and nutrient mining, although incomes may increase modestly. Model simulations show that adoption of a package of available technologies (shifts to higher yielding varieties, increased adoption of manure and fertilizer, tree planting on steep slopes, and community investments in drainage in the valley) can lead to large increases in incomes, increased food consumption and reduced soil erosion and nutrient depletion. The policies needed to achieve this potential include increased availability of credit, improved extension services (emphasizing a more site-specific approach to land management recommendations), and land tenure security. Collective action to construct and maintain a communal drainage system would also be important. Preliminary results from a bioeconomic model of farms in the Holetta area of Oromiya also indicate the importance of access to credit for increasing adoption of improved inputs and incomes (Ahmed and Ehui).

Overall, the evidence provided by the papers provides cause for hope as well as concern. There has been improvement in many measures of land management, natural resource conditions and human welfare in Tigray, despite the harsh environmental circumstances and high population pressure there. Small-scale irrigation systems are being established, adoption of improved inputs and conservation practices is occurring, woodlots and enclosed areas are regenerating, and indicators of wealth, health, education and other aspects of welfare are improving. Nevertheless, improvements in crop productivity have not been as large as one would hope and the availability and quality of grazing lands and fuelwood remain serious concerns. In lower potential areas as in much of Tigray and eastern Amhara, emphasis is needed on increasing the overall production of useful biomass (for food, feed, fuel, and soil fertility), and on the policies that will help to achieve this (e.g., allowing private tree planting on degraded lands, improved institutions for grazing land management, interlinking tenure security with conservation investments on private land, etc.). In higher potential areas as in western Amhara and much of Oromiya, there is greater potential for improved technologies relying on high levels of external inputs, especially in areas closer to roads. In these areas, policies relating to road development, supply of inputs, and credit are likely to be very important to achieving the potential for more rapid and sustainable development.

## OVERVIEW OF DISCUSSIONS

The discussions of the papers and issues among workshop participants provided many important insights and identified several areas where further refinement of the research questions and methods is needed. We will not attempt to provide an exhaustive

list of these comments, insights and suggestions here, but will summarize some of the key points raised.

“Sustainability” is a multidimensional and dynamic concept, encompassing considerations of interrelated economic, social and environmental factors. In order to be sustainable, development must be socially and environmentally sustainable, as well as economically sustainable. Although economic, social and environmental factors are all incorporated into the conceptual framework of the project, their relationship to sustainability needs to be clarified.

The concepts of “agricultural potential”, “market access”, and “population pressure” are also multidimensional and dynamic. Agricultural potential reflects differences in climate, soils, topography, access to water and other factors, and may vary over time in response to land degradation or improvement. Market access is more than access to roads or towns; it also depends on availability of transport services, purchasing power of consumers, access to international markets, etc. Population pressure also means more than simple population density; it relates also to population growth, the density of people relative to arable land, etc. These concepts also interact with one another; for example, the effect of increased market access may be different in high vs low population density settings. These points are well taken, and some of them are discussed in some of the papers presented, though they were not emphasized in the presentations. It is difficult to account for every dimension of such complex concepts in empirical analysis, though effort will be made to reflect these considerations to the extent possible.

Other development pathways should be considered in addition to those discussed in the papers. For example, there is little mention of forestry. Opportunities for income

diversification and increasing the value added in Ethiopian agriculture should be considered. Some of these opportunities are discussed in the papers in considering non-farm activities and high value products, but were not emphasized in the presentations.

One participant argued that the types and evolution of farming systems should be taken as an organizing principle for the research, to help simplify and clarify the policy implications. This is in fact what is intended by the concept of development pathways, which includes the evolution of farming systems as well as non-farm livelihood strategies. Another participant argued that the framework for considering development pathways, based on population density, market access and agricultural potential is too static, whereas the pathways should be dynamic. The project leaders clarified that these underlying factors are dynamic, though in many cases they change only slowly over time. The static presentation of these factors is to simplify the presentation, but dynamic aspects can be (and have been) taken into account in the empirical design and analysis. These issues should be presented more clearly in the future.

Many policy issues were raised and discussed in the discussions. Land policies were of considerable interest. Differences in the land policies across regions of Ethiopia were noted, and the need for learning from the different experiences of the different regions was apparent. For example, Tigray has formally ended land redistributions, Amhara implemented a redistribution in 1997, and Oromiya is still considering whether to have one. The implications of these different approaches for farmers' investments in soil and water conservation, tree planting, etc. would be valuable to investigate. There are also differences among regions in policies towards land leasing, allocation of degraded lands, private tree planting and other issues that are worth exploring.

The problems of managing small scale irrigation systems and the impacts of these systems were also of great interest. It was recognized that a lot of emphasis is being placed on investments in irrigation while the impacts have not been fully studied. Many participants were surprised by the limited impact of irrigation on adoption of inputs and yields found, and some did not believe these results. More information is needed to verify these results (some will be forthcoming from the household and plot level surveys, but a more targeted survey of irrigated areas would also be very useful). The impacts of irrigation systems on downstream users and on health also need to be studied. One study of the impacts of microdams on malaria in Tigray was discussed; that study found a strong association between distance to a dam and malaria at lower elevations, and that farmers were willing to pay significant amounts for health and preventative measures to address malaria problems.

Policies relating to management of community woodlots and grazing areas were also discussed. To some participants, it is remarkable that communities are not allowed to cut trees from woodlots in Tigray. Policy makers from Tigray indicated that communities are supposed to have discretion in how to use woodlots, but also stated that policies are currently being developed to clarify to communities their roles and responsibilities. Several participants mentioned problems due to the free grazing system, and the need to consider alternatives suggested. It was commented that more information is needed on the effectiveness of woodlot and grazing land management; i.e., to measure to what extent management of these resources is “optimal”.

The issue of eucalyptus planting was controversial. Many participants agreed that the economic returns to eucalyptus are high, but argued that ecological risks are also high

and that these tradeoffs need to be clearly elucidated. The absence of information on long-term effects of eucalyptus planting and broader hydrological effects is problematic. The authors clarified that studies on these issues are limited, and that those that are available indicate potential ecological benefits as well as risks. The impacts of large scale planting of eucalyptus on pole prices and profitability was raised as a concern; the authors clarified that conservative (low) estimates of pole prices were used to evaluate large expansion of planting, and that information on the price response to increased supply is not yet available. One participant clarified that the policy in Tigray of not allowing eucalyptus planting in farmlands was not enacted for environmental reasons, but because of food security considerations. The authors agreed that tree planting on farmlands could reduce food security in the near term, but pointed out that tree planting could be beneficial for food security in the long run, by giving farmers an alternative source of income in a drought year. Further research on these issues is needed (and is planned as part of a targeted survey of community and private woodlots).

The role of credit in promoting improved land management was discussed. It was argued that wealthier farmers might not demand credit because they do not need it, while poor farmers may avoid using credit for fear of losing their assets. The issue of how to obtain repayment when farmers suffer from a drought or other adverse event was raised: does it make sense to provide more credit to such farmers so that they may be able to repay? The effects of credit policy on land use, crop choice, conservation investments, land management practices, resource conditions and poverty should be investigated.

Some participants stressed the importance of social organization and social capital. Local land tenure institutions, organizations, religion, labor mobilization

campaigns and other factors may have a large impact on land management and its implications. The project leaders indicated that information on such factors has been/is being collected, but has not yet been fully analyzed. It will be easier to assess the impacts of some of these factors (such as religion and organizations) when data are available for all regions, since there is more heterogeneity in those factors across regions than in the Tigray region. These issues will be studied further as more information becomes available.

#### 4. LAND DEGRADATION IN THE HIGHLANDS OF AMHARA REGION AND STRATEGIES FOR SUSTAINABLE LAND MANAGEMENT <sup>1</sup>

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##### INTRODUCTION

This document is a summary of the result of the preliminary phase of the research project to characterize the nature and causes of land degradation in the highlands of Amhara region, and examine the opportunities for more sustainable land management and development. The preliminary phase is based on literature review, consultations with key officials, brief visits to selected field sites and discussions with farmers and key informants, and analysis of existing secondary data. The aim of this phase is to draw upon what is already known about the problem of land degradation and management to help develop research hypotheses and areas of focus for a community survey of 50 *Kebeles* that was launched in September 1999. The main objectives of the community survey are to identify the dominant “pathways of development”<sup>2</sup> in the region and to suggest hypotheses about their causes and implications for agricultural productivity,

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<sup>1</sup> The full paper is forthcoming in the Socio-economics and Policy Research Working Paper Series, International Livestock Research Institute, Addis Ababa, Ethiopia.

<sup>2</sup> A pathway of development is defined as a common pattern of change (or stagnation) in agriculture and livelihood strategies, associated with its causal and conditioning factors.

sustainable land management, and poverty. Those hypotheses will be tested using data collected in subsequent household- and plot-level surveys.

#### LAND DEGRADATION IN AMHARA REGION

Amhara National Regional State is located in the northwestern part of Ethiopia between  $9^{\circ}$ - $13^{\circ}45'$ N and  $36^{\circ}$ - $40^{\circ}30'$ E, with a total area of 170,152 square kilometers. Of the total area, cultivation and grazing land make up 30 percent each. Forest, shrub, bush, and woodland, water bodies, and wasteland make up 17 percent, 4 percent, and 16 percent of the total area, respectively, and the remaining 3 percent is taken up by settlement. The total population stands at 14.4 million, with an average land holding of 1.7 ha. About 35 percent of the nation's livestock population is found in the region, with the main feed sources being communal grazing lands, fallow lands, crop residues, and stubble.

*Soil erosion.* Site-specific test-plots and experiments in 1987 and 1988 at SCRP stations in the region show soil loss rates between 0.04 and 212 tons/ha/year. About 29 percent of the total area of the region experiences high erosion rate (51- 200 tons/ha/year). Thirty-one percent experiences moderate erosion rates (16-50 tons/ha/year), 10 percent experiences very high erosion rates (>200 tons/ha/year), and the remaining 30 percent experiences low erosion rates (<51 tons/ha/year).

*Nutrient depletion.* Loss of fertility is manifested through limited recycling of dung and crop residue in the soil, low use of chemical fertilizers, declining fallow periods, soil and organic matter burning, and soil erosion. Although the farming system in the highlands of Amhara is predominantly mixed crop-livestock, nutrient flows between the two is predominantly one sided, with feeding of crop residue to livestock but little or no dung returned to the soil. For example, UNECA shows that even though

almost all households (90 percent) fed crop residue to their livestock, only 40 percent used manure on their farmlands.

*Deforestation.* Removal of forests is prevalent and contributes to land degradation. About 20,000 ha of forests are harvested annually in the Amhara region for fuel, logging, and construction purposes. Since harvested trees are not replaced and, thus, expose the soil, about 1.9 to 3.5 billions tons of fertile topsoil are washed away annually into rivers and lakes due to deforestation alone.

The direct causes of land degradation, including declining use of fallow, limited recycling of dung and crop residues to the soil, limited application of external sources of plant nutrients, deforestation, and overgrazing, are apparent and generally agreed. Underlying these direct causes include population pressure, poverty, high cost and limited access to agricultural inputs and credit, fragmented land holdings and insecure land tenure, and farmers' lack of information about appropriate alternative technologies. Affecting many of these factors are government policies on infrastructure and market development, input and credit supplies, land tenure, agricultural research and extension, conservation programs, land use regulation, local governance and collective action, and non-governmental programs.

## DEVELOPMENT PATHWAYS

Considering the nature and causes of land degradation in the region, policy, institutional, and technological strategies for more sustainable, productive, and poverty-reducing development are identified. The main hypothesis is that the strategies for sustainable development in any given situation depend largely on the comparative

advantage of alternative livelihood strategies in that situation. While many factors determine comparative advantage, we focus on three: agricultural potential, market access, and population pressure.

Agricultural potential is an abstraction of many factors that influence the absolute advantage of producing agricultural commodities in a particular place, while access to markets is critical for determining the comparative advantage of a particular location, given its agricultural potential. Population pressure affects the labor intensity of agriculture through the land-labor ratio, and may also induce innovations in technology, markets and institutions, or investments in infrastructure and, thus, affects the comparative advantage of labor-intensive strategies of development. These three factors interact with each other in complex ways, and we can classify the highlands of Amhara into eight main types, considering two levels (“high” and “low”) of each factor. Table 1 shows the hypotheses about what opportunities exist in each situation.

In areas with relatively high agricultural potential and good market access, there is strong potential for intensified production of cereals using high levels of external inputs, commercial production of perishable cash crops such as fruits and vegetables, and/or intensive production of commercial livestock products such as dairy and poultry. There is also strong potential for rural non-farm development linked to agricultural development. Priority initially should be on intensified cereal production, since the need for food security is likely to constrain farmers’ ability to expand production of other (perhaps more profitable) products until cereal production is adequate. Development of credit, input and output marketing systems will be critical to the success of these pathways.

**Table 1: Opportunities for sustainable development in the highlands of Amhara**

| Agricultural potential | Market access | Population density  |  |
|------------------------|---------------|---|--|
|                        |               | High  | Low  |
| High                   | High          | <ul style="list-style-type: none"> <li>• High input cereals</li> <li>• Perishable cash crops</li> <li>• Dairy, intensive livestock</li> <li>• Rural non-farm development (20, 557)</li> </ul> | <ul style="list-style-type: none"> <li>• High input cereals</li> <li>• Perishable cash crops</li> <li>• Dairy, intensive livestock</li> <li>• Livestock and grazing improvement</li> <li>• Rural non-farm development (12, 405)</li> </ul> |
|                        | Low           | <ul style="list-style-type: none"> <li>• High input cereals</li> <li>• Non-perishable cash crops</li> <li>• Beekeeping (6, 192)</li> </ul>  | <ul style="list-style-type: none"> <li>• High input cereals</li> <li>• Non-perishable cash crops</li> <li>• Livestock and grazing improvement</li> <li>• Beekeeping (4, 71)</li> </ul>   |
| Low                    | High          | <ul style="list-style-type: none"> <li>• Low input cereals</li> <li>• Rural non-farm development (14, 354)</li> </ul>   | <ul style="list-style-type: none"> <li>• Low input cereals</li> <li>• Livestock and grazing improvement</li> <li>• Woodlots</li> <li>• Rural non-farm development (7, 220)</li> </ul>  |
|                        | Low           | <ul style="list-style-type: none"> <li>• Low input cereals</li> <li>• Beekeeping</li> <li>• Emigration (2, 65)</li> </ul>   | <ul style="list-style-type: none"> <li>• Low input cereals</li> <li>• Livestock and grazing improvement</li> <li>• Beekeeping</li> <li>• Emigration (10, 274)</li> </ul>   |

The figures in brackets are number of rural *weredas* and rural *kebeles*, respectively, that fall in each category.

In areas with high agricultural potential that are more remote from markets, comparative advantage is likely to be greater in production of high value (relative to volume) non-perishable cash crops such as nuts or coffee, and/or intensified production of easily transportable livestock (e.g., small ruminants). Even more than in areas of good market access, farmers' ability to produce sufficient food is likely to constrain their ability to expand production of such products. Thus, high priority should be given to

increased cereal production in such areas with food deficits through the use of imported inputs (particularly seeds and fertilizer). This may require subsidizing the cost of transporting inputs in the near term, as well as medium- or long-term credit to allow farmers to finance investments in perennial crops.

In areas with low agricultural potential but good market access, development opportunities are likely to be related to investment in irrigation where feasible and profitable; intensification of cereal production using limited amounts of inputs integrated with soil and water conservation and organic fertility management measures; intensification of livestock production through improved management of grazing lands and development of private woodlots (especially in lower population density settings); and rural non-farm development. These areas are likely to remain deficit producers of food, and so food aid may be needed in the near term, until the development potentials are more fully realized.

Opportunities for agricultural or rural non-farm development are even more limited in areas with low agricultural potential and poor market access. Intensified cereal production using limited amounts of inputs integrated with soil and water conservation practices and intensified livestock production is likely to be important. Beekeeping may also be an attractive option in some areas, and could be linked to vegetative regeneration in area enclosures (especially in lower population density settings). Food aid and emigration are likely to be essential. Thus, policies with respect to food aid, agricultural extension, education and training in non-farm activities, and land tenure will be of particular importance for these areas.

## 5. COMMUNITY NATURAL RESOURCE MANAGEMENT: THE CASE OF WOODLOTS IN NORTHERN ETHIOPIA

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### INTRODUCTION

Common property resources<sup>3</sup> are important sources of timber, fuelwood, and grazing lands in developing countries. Unrestricted access or ineffective use regulations have resulted in overexploitation of the resources. Reliance on appropriate policies and technologies, or efficient market prices alone cannot solve the problem of resource degradation in developing countries. Local level institutions and organizations play an important role in resource management. However, there is lack of evidence in developing countries regarding the nature and effectiveness of local level institutions and organizations of resource management. This paper seeks to address this lack of evidence on management of community woodlots in Tigray, Northern Ethiopia. The paper evaluates the nature and impact of community woodlot management and investigates the determinants of collective action and its effectiveness.

The Tigray region is located in Northern Ethiopia on the Sudano-Sahelian dry lands zone. More than 80 percent of the population depends on mixed crop-livestock subsistence agriculture. Since 1991, the region has embarked on a conservation-based

agricultural development strategy. The major natural resource conservation strategies include soil and water conservation investments on farmland, protection of area enclosures, development of community woodlots, development of small-scale irrigation, and reforestation. Popular participation has been an integral part of the resource conservation effort in the region.

## METHODS

Results are based on a survey of 50 *tabias* (the lowest administrative unit in Tigray consisting usually of 4-5 villages) and 100 villages in the highlands<sup>4</sup> of Tigray in the 1998-99 cropping season. A semi-structured questionnaire was administered with a group of representatives at both levels. Information was collected on changes in agricultural and natural resource conditions between 1991 and 1998, and their causes and effects. Analysis of descriptive information and econometric analysis were conducted.

The factors used to explain variations in collective action included population density, access to market, agricultural potential, the presence of external organizations, whether the woodlot is managed at the *tabia* or village level, and the area of woodlot. The indicators of collective action and its effectiveness in managing woodlots used in the econometric analysis included the amount of uncompensated labor contribution per hectare invested in managing the woodlots, whether there were any violations of use restrictions of woodlots, whether the community pays for guard to protect the woodlot,

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<sup>3</sup> Common property resources are defined as those resources that are owned and managed by a given community. They are to be contrasted with open access resources that have no defined owner.

<sup>4</sup> Highlands are defined as those areas above 1500 meters above sea level.

the number of trees planted per hectare on the woodlot since establishment, and the survival rate of the trees planted.

## RESULTS

Almost 90 percent of *tabias* have woodlots, with an average of nine woodlots per *tabia* and an average woodlot area of 8 ha. Most of the woodlots have been established since 1991 and have been promoted by an external organization, usually the regional Bureau of Agriculture and Natural Resource Development (BoANRD). The most common use allowed on woodlots is to cut and collect grass for feed and construction purposes. In almost all cases, a hired guard paid in cash or in kind protects the woodlot. A cash fine set by the community council usually punishes violations of community rules. The most common violations of use restrictions reported in 1998 include cutting grass, grazing animals, and cutting trees and branches. More violations and lower benefits were reported on *tabia*-managed than village-managed woodlots. Moreover, villages tend to use a more intensive management strategy. Woodlots contribute more than 5 million Ethiopian Birr (in 1998, 1 USD = 8 Birr) per community-to-community wealth on average.

Multiple regression analysis to explain the labor intensity of woodlot management, whether the community pays for guard, whether any violations of use restrictions occur, and the survival rates of trees supports the hypothesis of an inverted U-shaped relationship between population density and collective action (i.e., greater collective action to protect and manage woodlots at intermediate population density than at low or high density), perhaps because of less need for collective action when

population density is low and difficulties of maintaining collective action when density is high. Communities that are more remote from markets provide greater collective labor input, plant trees more densely, and achieve higher survival rates, perhaps because the opportunity costs of labor or the opportunities to escape community sanctions for non-cooperation are lower further from markets. The presence of external organizations was negatively associated with whether the community pays for a guard, since external organizations often pay for the guard. The presence of external organization was also negatively associated with tree survival, suggesting that external programs may not be achieving full participation of local communities in woodlot management. We failed to find evidence of economies of scale in woodlot management in Tigray.

## CONCLUSIONS AND IMPLICATIONS

Collective action in managing woodlots generally functions well in Tigray, supporting the role of community resource management in redressing resource degradation. Despite small current benefits, woodlots contribute substantially to community wealth. Benefits are higher and management problems lower on woodlots managed at the village level. We found some support for the hypothesis of an inverted U-shaped relationship between collective action and population density. Access to market appears to undermine the intensity of collective management of woodlots and its effectiveness, probably by increasing the opportunity cost of labor and/or the ‘exit options’ of community members. The results imply that community resource management can be an effective means of redressing resource degradation and increasing community wealth. Public intervention in community resource management needs to be

demand driven and complementary to local effort. Community woodlot management may be more effective if conducted at the lowest level.

## 6. COMMUNITY RESOURCE MANAGEMENT: THE CASE OF GRAZING LANDS IN TIGRAY, NORTHERN ETHIOPIA

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### INTRODUCTION

Communal grazing lands are important sources of livestock feed in developing countries. In the presence of sufficient demand for livestock and livestock products, unrestricted access to the grazing lands would result in overexploitation of the resource. Community grazing land management is being recognized as a viable alternative to privatization or state ownership and regulation to reduce the problem of grazing land degradation. However, there is a paucity of evidence regarding the nature of local level institutions and organizations for grazing land management in developing countries, or their effectiveness. This paper seeks to contribute to this gap of knowledge for the Northern Ethiopia region of Tigray. The paper evaluates the nature and impact of community grazing land management and investigates the determinants and effectiveness of collective action for the management of grazing lands in the region.

The study area, Tigray, is found in northern Ethiopia covering an approximate area of about 80,000 square km. More than 80 percent of the population depends on a mixed crop-livestock system, with oxen power supplying the only draft power for traction. According to the 1998 livestock census, the region has about 3.05 million cattle,

0.94 million sheep, 1.47 million goats, 0.42 million equines, and 0.013 million camels. Feed shortage is the major constraint to livestock production in the region. Free and uncontrolled grazing is the dominant grazing system in the region. In most parts of the region grazing lands are severely degraded.

## METHODS

The results are based on data collected from a survey of 50 *tabias* (the lowest administrative unit in Tigray usually consisting of 4-5 villages) and 100 villages in the highlands<sup>5</sup> of Tigray in the 1998-99 cropping season. A semi-structured questionnaire was administered in a group interview with community representatives at both levels. Data was collected on changes in agricultural and natural resource conditions between 1991 and 1998, and their causes and effects. Analysis of descriptive information and econometric analysis was conducted.

The factors used to explain variations in collective action and its effectiveness in managing grazing lands include population and livestock densities, access to market, agricultural potential, area and age of the grazing area, and presence of external organizations. Collective action to manage grazing lands and its effectiveness was measured in terms of whether a community has any grazing areas with use restrictions, whether communities established penalties for violations of use restrictions, whether there were any violations of use restrictions, and whether violations were penalized when they occurred.

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<sup>5</sup> Highlands are defined as those areas above 1500 meters above sea level.

## RESULTS

Restricted grazing areas are common in Tigray. Every village has some type of grazing area and 74 percent of the surveyed villages have restricted grazing areas, with an average area of 24 ha per village. Most restricted grazing lands were not promoted by external organizations. Only about 17 percent of the restricted grazing areas were established after 1991, indicating that there is a long tradition of developing and enforcing use regulations of grazing lands in the region. Almost all restricted grazing areas are managed at the village level. The regional Bureau of Agriculture and Natural Resource Development (BoANRD) provides technical advice and material support. The most common contribution by village members in managing the grazing lands is a cash or in kind contribution for guard payment. Communities tend to use stricter penalties when violations of use restrictions are more frequent.

The relationship between population pressure and collective action to manage grazing lands appears to be mixed. While population pressure reduces violations of use restrictions of grazing lands up to an intermediate level of population density, supporting the hypothesis of an inverted U-shaped relationship hypothesis between population density and collective action, intermediate population pressure tends to reduce the likelihood of development of use restrictions and the enforcement of penalties. Perhaps penalties are less needed at intermediate population density because collective action works better in such circumstances, reducing violations and the need for penalties. Market access tends to favor collective action for grazing land management while the presence of external organizations retard it. These results suggest that community grazing land management can contribute to a more sustainable use of grazing lands and

the alleviation of feed shortage problems under the right circumstances. Public intervention in grazing land management needs to be complementary to local efforts.

## **7. AGRICULTURAL CHANGE AND LAND MANAGEMENT IN THE HIGHLANDS OF TIGRAY: CAUSES AND IMPLICATIONS**

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This study investigates changes in agriculture and land management practices between 1991 and 1998 in the highlands of Tigray, and the causes and implications of these changes, based upon a community level survey conducted in 100 villages in 50 tabias.

Since 1991, a broad process of development has been occurring in Tigray, involving substantial investments in roads, irrigation and other infrastructure and improved access to education, health care, water, agricultural extension and other public services. These investments and services have resulted in improvements in many aspects of life in Tigray, reflected in relatively upbeat responses that survey respondents provided to most of our questions about changes in welfare. The improvement in access to infrastructure and services has been even greater in areas that were less favored in 1991, helping to equalize access in the region, though improvement is still needed in most areas.

In addition to public investments and services, farmers have undertaken a substantial amount of private and community investment, including accumulating livestock assets (especially oxen), planting trees (both privately and in community woodlots), and investing in various soil and water conservation structures. They have also adopted more labor and capital-intensive agricultural management practices. These

private investments have contributed to improvements in resource conditions, most of which were also perceived by farmers to be improving in general.

We have investigated the determinants of changes in agricultural and land management practices and their implications for productivity, resource conditions and human welfare, and have identified a number of important tentative findings (subject to verification through analysis of ongoing household and plot level surveys in the region). The agricultural extension program appears to have effectively promoted more intensive land management and conservation practices, contributing to higher crop yields, increased wealth and access to food. However, it also appears to have contributed to worsening grazing land conditions. The Tigray Bureau of Agriculture and Natural Resources (TBANR) should investigate this problem further, and consider options to intensify and improve management of grazing lands.

Irrigation was found to be an important factor underlying different livelihood strategies, favoring production of perishable cash crops as well as non-farm activities relative to ruminant production as a source of cash income. Irrigation has contributed to intensified land use and to changes in crop choice, but has been associated with less adoption of fertilizers and improved seeds and less improvement in yields than expected. As a result, it appears that the returns to modern irrigation investment so far have been relatively low. This issue should be of high priority for further study, given the large amount of resources that are being invested in this development, and options should be considered to improve the returns to irrigation investment in Tigray. Among these options may be increasing the priority of extension activities in irrigated areas and

increasing emphasis on promotion of high value crops in such areas. Complementary investments in roads or other infrastructure may also be important in some areas.

Road development appears to have contributed to shifts in production away from livestock (especially cows) and to greater production of some cash crops. Road development is not as strongly associated with adoption of purchased inputs as we expected, but has contributed to changes in some agricultural practices, particularly reduced burning to prepare fields. This may be an important reason why yield improvement for barley and maize has been greater in areas with better road access, since burning is associated with declining yields. Road improvements are associated with increased food availability, improvement in the quality of grazing land (probably as a result of reduced emphasis on livestock production), and to improved availability and quality of water. Overall, road development has contributed to agricultural development and improved resource management and human welfare.

Population pressure was found to increase several indicators of the labor and capital intensity of agriculture. However, this intensification did not result in significantly increased yields, suggesting that land degradation caused by population pressure is reducing cropland productivity. The quality of grazing land is also being degraded by population (and associated livestock) pressure. Despite these negative indications, differences in measures of human welfare were generally unrelated to population pressure, and in some instances population pressure was associated with improved conditions. This is likely due to greater investments in infrastructure or public services in areas with greater population pressure, suggesting the importance of such investments in maintaining and improving welfare in the region despite high population pressure.

Educational improvements appear to have contributed to several aspects of agricultural intensification and technology adoption, including use of fertilizers and vaccines and adoption of some intensive land management practices such as composting, planting trees and live fences. Despite this, there is a puzzling association between education and declines in soil fertility and yields of some crops. This may be related to the fact that fallowing is declining more rapidly in areas where farmers are more educated. This suggests the importance of teaching principles of sustainable land management in school curricula. Aside from this negative association of education with soil fertility, the impacts of education on many other natural resource conditions (e.g., the quality of grazing land, forest, and water) are positive and large. Education is also strongly associated with reductions in infant mortality. Thus the overall benefits of improved education for resource management and human welfare appear to be quite substantial.

Differences in livelihood strategies have also led to important differences in land management and in productivity, resource conditions, and human welfare. Areas where non-farm employment is important have performed better than other areas in several respects, including improvement in crop yields, food availability, reduced erosion, and improved availability and quality of water. Promotion of non-farm development thus appears to offer potential as a more productive and sustainable development pathway for the region. Realization of this potential appears to depend upon agricultural development, however, given the strong association of this strategy with irrigation investment. Development of cash crops, including perishable annual crops and perennials, is also strongly associated with irrigation investment, and also helps to reduce pressure on grazing land and cropland erosion. In many areas, however, the potential for

development of cash crops or non-farm activities is low. Livestock will continue to be critical to the development strategy of these areas. A critical issue for these areas will be to increase the productivity and sustainability of grazing land management.

Overall, development in Tigray since 1991 has been impressive and conditions are generally improving. Nevertheless, important problems and challenges remain. It is hoped that this study will help policy makers to identify some key areas to focus on, in order to continue to achieve broadly shared and sustainable development in the region.

## 8. SMALL SCALE IRRIGATION IN TIGRAY: MANAGEMENT AND INSTITUTIONAL CONSIDERATIONS

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### INTRODUCTION

Irrigated agriculture is at the heart of the Agricultural Development-Led Industrialization and Food Security Strategy of the Ethiopian government. Increased availability of irrigation and less dependency on rainfed agriculture is taken as a means to increase food production and self-sufficiency of the rapidly increasing population of the country.

In line with the development policy of the country, the Regional Government of Tigray is promoting irrigation development so as to increase and stabilize food production in the region. Since the establishment of the Commission for Sustainable Agriculture and Environmental Rehabilitation (Co-SAERT) by the Regional Government, many earthen microdams and river diversions have been built and rehabilitated. Other non-governmental organizations and communities are also undertaking water resource development activities with the same objective. Besides development of new schemes, some traditional systems are also rehabilitated.

The major emphasis of the irrigation development initiatives in Tigray has been on technical issues. Issues such as beneficiaries' selection, land tenure, water use rights

and water allocation, determination of minimum irrigable plot size, operation and maintenance, water fee, and establishment and strengthening of water users associations are important for sustainable and effective irrigation development. The implementation of irrigation projects will bring changes in land use pattern and intensity, land and labor productivity, household resource requirements and tenure issues which require management and institutional consideration. However, very little is known about how these socio-economic and institutional factors are affecting irrigation development in Tigray. This paper tried to assess the status of irrigated agriculture development in Tigray and the major management and institutional issues worth considering.

The results are based on data collected from two separate surveys; a survey on land tenure issues in small-scale irrigation development in Tigray conducted in 1999/2000 and community level survey on land management conducted in 1998/99. The former survey covers seven selected irrigation sites: both traditional and newly constructed irrigation schemes. The community survey also covers the experience with regard to irrigated farming in 50 *tabias* or communities in Tigray. Descriptive information generated from the survey was used to characterise the irrigation systems, and the role of local communities and external organisations in irrigation management in Tigray.

## THE SETTING

Tigray is the northern-most region of Ethiopia and it covers an approximate area of 80,000 sq km with a population of more than 3.3 million and annual population growth rate of 3 percent. The region is one of the most drought prone and food insecure regions of Ethiopia. The climate of Tigray is mainly semi-arid and for most part of the region the

main rainfall season (locally called *Kiremti*) is for three to four months during June to mid-September. The mean annual rainfall ranges from 980 mm on the central plateaux to 450 mm on the northeastern escarpments of the region. The annual rainfall shows high degree of variations with the coefficient of variation ranging from 20 percent in the western to 49 percent in eastern parts of Tigray. Tigray enjoys different types of temperature ranges depending on altitude, ranging from temperate type in the higher areas to tropical in the lower areas. The average temperature in the region varies from 16°C in the Southwest to 25 ° C in the extreme eastern areas.

The economy of Tigray is entirely dominated by peasant agriculture practising traditional methods of crop production and livestock rearing. Agriculture accounts for 65 percent of the regional GDP. However, the annual growth rate of production is only 1.2 percent, which is below the national average, while population is growing annually at 3 percent per annum.

The water resource of Tigray is not well studied. The available studies indicate that only about five perennial streams have more than 10 litres per second flow rate. The annual loss of water through the three major drainage systems of the region during the rainy season is immense. In total through the Tekeze, Mereb and Dennakil basins 9 billion m<sup>3</sup> of water goes from Tigray to neighbouring countries every year; which is almost equivalent to the 9.21 billion m<sup>3</sup> total estimated rainfall in the region. If 50 percent of the 9 billion m<sup>3</sup> of the runoff were used, half a million ha. of land, which could feed three times the present population of Tigray, can be irrigated. Thus, water harvesting and management are of paramount importance so that excess water can be stored and later used for irrigation and other purposes. In Tigray the estimated irrigation

potential is 324,286 ha. out of which 15, 495 ha. is actually irrigated, mainly through traditional practices. Large-scale water resource development is not yet started.

## IRRIGATION SYSTEMS

Though there is inadequate documented evidence regarding the history of irrigation practices in Tigray, some evidence dating back to 500 B.C indicate that irrigation was practiced in the ancient village of Yeha in Adwa and some other places. The descriptive data from the 50 communities surveyed indicate 49 of the communities have access to 2 or 3 minor irrigation sources. It also indicates that 90 percent of the microdams and 62 percent of the introduced river diversions were constructed after 1991.

In Tigray, surface irrigation is the predominant form of irrigation, including spring development, river diversion, flood spreading, microdams and pond systems. The canal systems are mainly unlined and the density of tertiary canals on farmers' fields is often not high enough to ensure efficient water management. There are also limited ground water systems.

Based on the study carried out, a total area of 1895 ha is irrigated using spring systems in the surveyed communities. Besides, irrigated agriculture in the region constitutes about 4500 ha by river diversion systems, 5000 ha by flood diversion and spreading systems and 2018 ha by microdam systems. The significance of the pump and pond system is not well known.

The results of the descriptive analysis indicate that there a very few cases in which farmers encountered minor problems of farmland loss, conflict over access to irrigation and increased diseases and pests. In the majority of the irrigation systems these problems are

almost non-existent. However, some of these problems evolve over time and their absence currently does not mean they will not occur in the future. Thus, to protect and control these problems regular follow-up and proper management is necessary.

#### SOCIO-ECONOMIC, INSTITUTIONAL AND MANAGEMENT ISSUES

The following issues are worth considering for the effectiveness of irrigation development in Tigray.

- The economics of small-scale irrigation in Tigray is not well investigated. Economic evaluation of the optimal plot size, the cropping patterns, technologies, agronomic practices and resources utilised in the irrigation schemes is necessary.
- The small-scale irrigation systems are often widely scattered and thus the provision of inputs, services and technical advice may be difficult given the poor infrastructure. This requires the involvement and co-operative effort of beneficiaries.
- Local communities are playing major role in irrigation development in Tigray. The current approach, which focuses on empowerment of local communities, should continue and be institutionalised.
- Lack of technological support is the major problem of irrigation development in Tigray. Participatory research and on-farm testing of low-cost technologies should be an immediate priority of the rural technology centres and research and extension institutions.

- Local marketing and trade should be promoted by improving infrastructure and institutional changes. The lack of viable product markets and marketing institutions is the major problem. Government and other institutions should focus on addressing marketing problems.
- The rural credit systems should encourage adoption of available low-cost technologies.
- Promoting complementary enterprises should be given due attention so as to optimise the efficiency of the irrigation systems.
- The relationship between water rights and rights to land are not clear in Tigray. It requires clarification so that expensive irrigation water can be utilized properly.
- In water resource development, harmonizing the different demands for water, establishing irrigation priority rights between upstream and downstream users, and considering the rights of existing users of water from floods which may be modified by dams is essential. However, this issue has not been addressed in Tigray. Local communities are resolving the matter through their community norms, but it requires a formal institutional approach based on the local experience.
- A comprehensive irrigation policy clarifying the water rights, water fee and cost recovery systems, irrigation technology, intervention affecting traditional irrigation practices and the role of local communities and individuals should be finalized and implemented.

## CONCLUSIONS AND IMPLICATIONS

Rapid growth of small-scale irrigation constitutes a major achievement of the agricultural development and food security strategies in the region. However, these achievements should be assessed in an integrated manner. The planning process in the area of irrigated agriculture should equally assess the socio-economic, institutional and management issues besides the technical ones.

## **9. THE ROLE OF TREES FOR SUSTAINABLE MANAGEMENT OF LESS FAVORED LANDS: THE CASE OF EUCALYPTUS IN ETHIOPIA**

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Northern Ethiopia is currently suffering from severe woody biomass shortages, water scarcity, soil erosion and land degradation. These environmental problems are exacerbated by the problem of increasing numbers of poor people practicing subsistence agriculture on less favored or marginal lands. One of the most promising medium-term responses to the problem of woody biomass depletion and land degradation in Tigray is the planting of fast growing eucalyptus. This resilient tree species performs better than most indigenous woodland and forest tree species in northern Ethiopia. In addition to increasing biomass and providing ground cover that slows land degradation, the sale of eucalyptus poles and products has substantial potential to raise farm incomes, reduce poverty, increase food security and diversify smallholder farming systems in less favored areas of northern Ethiopia.

Despite the potential for eucalyptus to improve rural livelihoods, the regional government of Tigray has imposed a ban on eucalyptus tree planting on farmlands since 1997. The ban is a result of the government wanting to ensure that farmlands are utilized primarily for food production, and is also related to the belief that there are significant negative environmental externalities associated with eucalyptus trees. The regional government promotes planting of eucalyptus and other species in community woodlots, and has recently begun to allow private planting of eucalyptus on community wastelands

and steep hillsides. Information on the ecological and economic impact of eucalyptus tree planting in this region is needed.

The ecological impacts of eucalyptus are mixed. Fast growing eucalyptus may be the best short-term option for providing critically required biomass in the region. Eucalyptus produces more biomass than other tree species under similar conditions in Ethiopia (i.e., the minimum mean annual increment of eucalyptus on poor quality sites is approximately 10 m<sup>3</sup> on poor sites, compared with 1.2 m<sup>3</sup> for indigenous species). By providing a source of fuelwood, eucalyptus may reduce burning of dung and crop residues and thus help to reduce farmland degradation by allowing more of these organic sources of nutrients to be recycled to the soil. With respect to soil erosion, evidence indicates that the effect of eucalyptus on soils and topsoil retention on degraded hillsides is positive due to strong root systems that halt the mass wastage of slopes, and reduce wind erosion. However, there is also evidence that eucalyptus can out-compete crops for nutrients—leading to soil depletion. Further, allelochemicals in eucalyptus leaf litter alter soil mineral content and may be responsible for reduced growth in teff and chickpea. The ability of eucalyptus to withstand water logging and tap deep water sources during times when food crops may fail is beneficial; however, there is evidence that water can be competed away from other crops as far as 10 meters away from where eucalyptus trees are planted. The long-term and broader hydrological impacts, including down stream affects of wide-scale eucalyptus planting are not known. Finally, the common eucalyptus species grown in Ethiopia (*E. camaldulensis* and *E. globulus*) are drought, flood and fire resistant, and not currently threatened by pests.

Because smallholders and communities make land use decisions based upon socioeconomic criteria as well as potential ecological implications, it is important to consider the economic conditions that facilitate tree planting. We hypothesize that the areas best suited to eucalyptus will be areas with low opportunity cost of land (e.g., wastelands and other areas with low agricultural potential) where potential negative externalities can be minimized (e.g., in low population density areas), with good access to inputs (i.e., seedlings), with efficient and elastic output markets, where households have low discount rates and access to long-term credit, and where access to benefits is not restricted by local institutions. Only some of these characteristics are present in Tigray. For example, there is substantial wasteland area with low or no opportunity cost, and tree seedling production and distribution is currently sufficient to meet demand. However, the elasticity of output markets (i.e., primarily markets for construction poles and fuelwood) is uncertain, discount rates are likely high, there is no access to long term credit, and access to woodlot benefits are limited due to lack of a clear policy allowing harvesting of woodlots by local communities.

To provide some information on the economic potential for eucalyptus production and also to assess some of the potential effects of ecological impacts on returns to investment we provide *ex ante* internal rates of return (IRR) estimates for four scenarios using community survey data from Tigray. In our base case scenario we estimate a minimum IRR of 19 percent for *tabia* managed community woodlots on a site where the opportunity cost of land and wage rates are high, pole prices are low, and three consecutive coppice crops are harvested on a 10-year rotation with harvests being adjusted for average survival rates. On sites with low opportunity costs of land under

conditions where wage rates are low and pole prices high, *ex ante* IRR estimates are as high as 67 percent for privately managed woodlots situated on degraded community land. In our second scenario we consider the impact of variable rotation ages on rates of return and find that reducing the rotation age to five years yields *ex ante* IRRs as high as 173 percent and lengthening the rotation age to fifteen years yields IRRs as low as 10 percent for *tabia* managed woodlots. Our third scenario addresses the issue of potential crop production losses. Estimates indicate that even a 100 percent crop production loss in an area extending 10 meters from a one-hectare woodlot results in only a 4-6 percent decrease in social rate of return estimates. Finally, we consider the variability of rates of return among administrative zones in Tigray.

Based upon our discussion of the ecological and economic parameters affecting smallholder decisions to plant trees, as well as our *ex ante* benefit-cost estimates we discuss several potential policy options for eucalyptus tree planting in Tigray. These policy options (which are not mutually exclusive) include:

- promoting more localized woodlot management by increasing local communities' authority to manage community woodlots or by encouraging management of community woodlots at the *kushet* (village) level rather than at the *tabia* (community) level,
- privatizing management (but not ownership) of community woodlots,
- allocating hillsides and degraded land for private tree planting,
- allowing eucalyptus tree planting on farmlands, subject to regulation, and

- promoting eucalyptus planting and sustainable management through availability of long-term credit, training and education.

As criteria for evaluating these policy options we consider factors such as the potential impact on aggregate income and wealth, potential impacts on food security, distribution of costs and benefits, ecological and sustainability impacts, and the ease and cost of implementation.

The policy option with the greatest potential economic benefit as well as favorable ecological implications is to allocate community wasteland for private tree planting. If the estimated 334,000 hectares of wasteland in Tigray were planted to eucalyptus at the median planting density of private woodlots (approximately 3000 trees/hectare), 70 percent survive, and trees worth 17 Ethiopian birr (a conservative estimate based upon our price data) are harvested every 10 years, the annual increase in income would be more than 370 Ethiopian birr per capita (almost half of the 1998 Ethiopian GDP/capita), if we assume a relatively elastic and stable market for woodlot products. Assuming a 10 percent social discount rate, the net present value of this investment would be about 2,000 Ethiopian birr per capita. Gains in income and wealth would likely lead to improved food security, with potentially very large benefits for the landless and land poor who could be priority recipients of wasteland allocations. The potential positive ecological implications of this policy option include reduced pressure on indigenous forests, reduced burning of dung, watershed protection and reduced erosion. However, the long-term implications, particularly with respect to downstream effects are unknown. This policy is likely to be relatively easy to implement, though the

supply of seedlings, as well as the provision of forestry extension education and support may be constraints.

More localized management of community woodlots is also a favorable policy option that could be considered. More localized management is likely to increase returns to woodlot investments, improve food security through income generation, and environmental sustainability through the use woody biomass for fuel, replacing or substituting the high proportion of dung and crop residue currently utilized for fuel in Tigray. Allowing the planting of eucalyptus on farmlands also offers substantial benefits; however, there are much greater costs (i.e., opportunity cost) and environmental risks, and this could undermine the profitability of other options, such as allocating wastelands for tree planting. Thus we do not recommend that this policy be pursued, at least in the near term. Finally, access to long-term credit as well as the facilitation of forestry education and training, including emphasizing the importance of planting indigenous trees as well as fast growing exotic species, would be complementary to all policies.

## 10. NATURE AND CAUSES OF LAND DEGRADATION IN THE OROMIYA REGION: A REVIEW OF LITERATURE

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### INTRODUCTION

The objective of the paper is to identify the nature of and principal factors causing land degradation in the Oromiya region and to provide empirical evidence relating to land degradation based on available literature and secondary data. This will lead to identification of gaps in knowledge about land degradation processes and the causes, and development of hypotheses about possible pathways to intensify agriculture in a sustainable way. These hypotheses will be tested with field data to be collected later.

Oromiya is located in the central part of Ethiopia extending from 3<sup>0</sup>20<sup>1</sup>N to 10<sup>0</sup>35<sup>1</sup>N and from 34<sup>0</sup>05<sup>1</sup>E to 43<sup>0</sup>11<sup>1</sup>E with a total land area of 353,690 km<sup>2</sup>. It constitutes about 31.2 percent of the total land area of the country, making it the largest of the 14 regions.

The region has variable topography consisting of a high and rugged central plateau, which is divided into two by the Great East African Rift Valley, and the peripheral lowlands. Elevation in the region ranges from less than 500 to over 4,300 meters above sea level, with the highlands (>1500 m.a.s.l.) constituting about 48 percent of the region's area. Mean annual temperature ranges between 10<sup>0</sup>C and 22<sup>0</sup>C in the

highlands and between 22<sup>0</sup>C and 30<sup>0</sup>C in the lowlands. Annual average rainfall in the region ranges from 200 mm to over 2100 mm.

The total human population in the region was 20.5 million in 1998 and growing at the rate of 3 percent, while the livestock population is estimated to be about 18.7 million Tropical Livestock Units (TLU). The highlands host more than 80 percent of the total human population and 70 percent of the livestock population in the region and account for over 90 percent of the cropland. Almost 90 percent of the region's economic activities are concentrated in the highlands.

#### CAUSES AND EFFECTS OF LAND DEGRADATION IN OROMIYA

The major forms of land degradation in the region are deforestation, soil erosion and soil nutrient depletion. Some of the proximate and underlying causes of land degradation are discussed below.

*Soil properties:* Soils vary in their resistance to erosion. For instance, inceptisols and vertisols by their very nature are fragile and sensitive to both geological and man-made erosion. These soil types are among the major soil groups in Oromiya covering the Chercher highlands (Harerge), the central highlands and basins in western Oromiya where soil degradation rates are also observed to be high.

*Climatic factors:* Major climatic factors that determine soil erosion in the region include rainfall and wind. Rainfall intensity is more important than rainfall amount in causing erosion because a high proportion of rainfall occurs in a short period. Sheet and rill erosion are by far the most widespread kinds of erosion and are more significant to agricultural production than other kinds of erosion. Rainfall with an intensity exceeding

7.6 cm/hour for 5 minutes, 3.6 cm/hr. for 15 minutes, 2.5 cm/hr. for 30 minutes, or 2.0 cm/hr. for 60 minutes is classified as an excessive and erosive rate of rainfall. Rates much higher than these threshold levels are common in the region, and such intense rainfall events caused about 50 percent of the total soil loss from some test plots in the region.

*Soil formation vs loss rates:* Estimated rates of soil formation in Ethiopia vary between 2 and 22 t/ha/yr, while soil loss rates range from 51-200 tons/ha/yr (dominantly from 51-100) in some parts of Sidamo and Bale highlands, and from 100- 200 tons/ha/yr on sloping cultivated land in parts of Ilubabor. .

*Vegetation and land cover:* Generally, erosion rates are lowest in areas of undisturbed forests. The removal or destruction of vegetative cover and frequent tillage lead to soil erosion. Due to decreases in the degree of vegetation cover, increased tillage that leave the surface smooth, the large number of livestock and their frequent trekking for water and grass, and poorly constructed roads, both water and wind erosion is becoming a serious problem in Oromiya, especially in the rift valley and associated lowlands. Recent estimates indicate that 3.1 percent of the natural forests in Oromiya are annually lost. A study in three Peasant Associations of Adaba and Dodola (Bale zone) during 1993-97 shows that the annual rates of deforestation were 1.6 percent, 9.4 percent and 5.6 percent respectively. Another study conducted during 1996-98 in Belete forest and Gera forest of Jimma zone shows that the annual rates of deforestation were 9.5 percent and 4.7 percent respectively.

*Nature of economic activities and land use practices:* Different types of economic activities and their associated techniques of production or practices cause varying levels of land degradation. For instance:

- In Metu area, a test plot covered by teff, which requires fine tillage, exhibited runoff almost four times higher than that of a plot under maize (437 mm vs 112 mm) under the same slope conditions (both 18 percent). Forest coffee on much steeper slopes (51 percent) showed the least runoff throughout the test period, with a maximum of only 36 mm. Over 81 percent of soil erosion in Chiro wereda has been attributed to practices such as cultivation on steep slopes, runoff from surrounding fields, cattle tracks and footpaths and defective soil conservation measures.
- An equivalent of about 5.4 to 6.8 million G cal of animal dung is used for fuel in the region per year. Use for dung as fuel means denying the soil of this effective conditioner and fertilizer. This practice is most pronounced in areas where forest cover has more or less disappeared and where acute fuel shortage is being felt, as in East Shewa, North Shewa, West Shewa, Arsi, and Bale. Some other local practices for soil management are also decreasing in importance.
- Generally, the rate of mineralization is high in the absence of natural cover when topsoil is exposed to unusually extreme temperature and humidity. There is evidence that organic matter increases as the length of fallow period increases, and decreases as cultivation period becomes longer. In the Metu area, Illubabor zone of Oromiya region, soil organic matter content dropped from 20 percent to 7 percent in less than three years of continuous cultivation due to mineralization.
- About 52 percent of the total land in the crop-livestock system of the highlands is used for grazing and browsing. The current estimates indicate that the total

feed requirement in the region is higher than the naturally available feed potential. Accordingly, the feeding balance estimation made based on Fodder Unit (FU) reveals that there is a significant deficit (23.5 percent) of feed supply in the region, resulting in overgrazing of pasture lands at least in some parts of the region.

*Population pressure and poverty:* Population pressure has led to cultivation of marginal land and steep slopes, causing land degradation. The level of poverty of people, their level of knowledge, perception and attitudes and degree of infrastructure and local market development also impact on land degradation. For example:

- Throughout highland and midland Chiro, Eastern Oromiya, despite a guideline to cultivate only lands with slopes below 35 percent, increased population pressure forced farmers to cultivate areas with slopes of 50 percent gradient, thereby contributing to the degradation process. In Melkedera peasant association of Ambo wereda in Oromiya, population has increased by 25 percent in ten years since 1984. Resettlement in 1984/85 is reported to have increased the population of Sor Awraja of Illubabor by up to 12 percent, leading to pressure on land and its quality.
- In some parts of the region, increasing population pressure led to fragmentation and intensive cultivation without better quality inputs, leading to degradation. A study in Dizi catchment in the Metu area showed that the amount of land put under cultivation was 30 percent and 41 percent of total area or 38 percent and 51 percent of the land available for cultivation in 1957 and 1982 respectively, causing the crop:fallow cycle ratio to fall from about

1:2 to 1:1 in this period. About 29 percent of the families in Ambo wereda do not have access to land, while at least 30 percent of the households hold less than half a hectare of land. A survey in Agucho village in West Harerge showed that cultivated land per capita decreased from 0.29 ha in 1983 to 0.12 ha in 1988.

- The level of poverty of people also determines their behavior in terms of conservation or degradation of natural resources. For instance, due to the increasing poverty in Melkederu PA in Ambo wereda, relying on off-farm activities including marketing forest products has become common practice for the people. A forest dependency survey conducted in the area shows that 22 percent and 33 percent of the households in the PA are occasional and regular dependents on forest, respectively, for their livelihood.

*Land tenure policies:* Land tenure has over the years been one of the most important institutions that affect land management decisions in Oromiya. Theoretically, tenure security and investment on land and hence better management of land including use of appropriate technologies are positively related. Land tenure security has been generally poor under all the three regimes in recent periods: feudal, Derg and current regimes. The Emperor during the feudal period confiscated and granted all the lands as and to whom he chose. During the Derg and current regimes, rural farmlands belong to the “people” but are controlled by the Government. As a result, there were frequent redistributions by the government to accommodate new families. For instance, in Tiyo wereda, there have on the average been 3.5 land redistributions per household while 17 percent of all PA members have experienced five or more redistributions since their first

allocation in the mid 1970s. Such uncertainty would be expected to reduce incentive for investment in better management of land.

*Research and extension policies:* The history of agricultural research and extension is not very long in the region. Moreover, research and extension activities throughout the past periods were concentrated on crop improvement and productivity-increasing technologies and inputs. Conservation per se has received little attention. Also, research and extension served the large-scale private and state-owned commercial farms rather than the smallholder sector. Consequently the vast majority of the smallholder farms have benefited very little from research and extension programs. Some efforts have been made by both government and development agencies to introduce conservation technologies, but these were not sustained once the outside initiative and support were discontinued.

*Effect of degradation on productivity:* As erosion reduces crop productivity, the degree of control of erosion declines, due to decreasing vegetative cover. Therefore, once crop productivity begins to decline because of soil degradation, land degradation becomes self-perpetuating. Crop yields on severely degraded soil are much lower than those on protected soils because erosion reduces soil fertility and water availability. In West Harerge, a 72 percent yield reduction of barley was observed as a result of soil erosion over a 15-year period.

## POSSIBLE PATHWAYS OF SUSTAINABLE LAND MANAGEMENT IN THE REGION

The main factors that may determine comparative advantage of different development pathways include agricultural potential, market access, and population

density. In terms of agricultural potential, Oromiya region falls into three broad agroecological zones: high potential cereal zone, low potential cereal zone and perennial zone. Vertisols are common in the high potential cereal zone and a major constraint in this zone is water logging and drainage. In the low potential cereal zone, low productivity, high risks and limited options are constraints. In the perennial zone, soil acidity is a general problem. Each agroecological zone has domains with a combination of population density and market access gradients, which also define opportunities and constraints. Therefore a diversity of situations exists in the region requiring identification of different set of appropriate technology options and policy and institutional support mechanisms. However, policy options may be more general and widely applicable than technology options. For example, intensification of cereal production using high quality external inputs and expansion of perishable cash crops may form two major strategies for the high potential cereal zone with good market access. In the low potential cereal zone with low market access and low population density an appropriate strategy may be to increase the productivity of the mixed crop-livestock system by improved management of grazing lands and woodlots and integrated soil nutrient management on cultivated land. Given that this area is inherently degraded or of low fertility, special attention for improvement of soil quality may be needed. The potential of these possible pathways will be validated through household and plot level surveys.

## **11. TECHNOLOGY AND POLICY IMPACTS ON NUTRIENT FLOWS, SOIL EROSION AND ECONOMIC PERFORMANCE AT WATERSHED LEVEL: APPLICATION OF A BIOECONOMIC MODEL**

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### **BACKGROUND**

Land degradation, low productivity, poverty and declining human welfare are the dominant problems of the crop livestock production systems prevalent in most parts of the tropical highlands. This study examines soil nutrient balances arising from the driving forces behind these problems using a watershed framework of analysis, as opposed to a farm household approach, and applying a bio-economic model, as opposed to a purely economic or biophysical model. The model is validated in the Ginchi watershed in the central highlands of Ethiopia. The current situation of limited technological and policy intervention in the watershed is compared with the situation involving single and multiple interventions. Given the current shift in focus from increasing agricultural production per se (through overcoming soil constraints to fit plant nutrient uptake by use of purchased inputs), to minimization of external inputs use and maximization of their efficiency, this study utilizes a nutrient balance monitoring technique to gain insight on the effects of proposed technology and policy interventions on the gains and losses of major nutrients in the watershed. Hence judicious measures

that manipulate nutrient flows to result in reduction in nutrient losses or increase in nutrient gains are explored.

Cross-sectional socio-economic and biophysical data from four land categories found in the watershed for the years 1995, 1996 and 1997 are used to test the model and are supplemented with on-station experimental data. Output from the validated dynamic model is then used to generate nutrient balances arising from the interactions and interrelationships between technological and policy interventions on one hand and biophysical and human factors on the other.

#### BIOECONOMIC MODEL RESULTS

Two versions of the bio-economic model are generated: a) a static goal programming version, and b) a dynamic non-linear mathematical programming version. The static goal programming approach simultaneously optimizes both environmental and economic goals of the watershed and its results are used to validate the dynamic model. The dynamic model optimizes an aggregate watershed utility function that is indirectly linked to the biophysical aspects of the watershed through an exponential soil loss-yield decline model with single year time lags. Soil losses in one year determine yields of various crops in the following year given the ameliorative effects of chemical and dung fertilizer. Both versions of the model take into account seasonality in input and output supplies, labor substitutability, the various roles of gender, crop and livestock constraints, minimum household food requirements, forestry activities as well as the biophysical aspects of soil erosion and nutrient balances arising from these activities.

With limited technological intervention over a twelve year planning period, incomes rise by 50 percent from a very low base and average per ha nutrient balances stand at -58 kg for nitrogen, -32 kg for phosphorous, and -114 kg for potassium. Associated soil losses are 31 tons per ha. With a set of new technologies involving use of new high yielding crop varieties, agro-forestry, organic (animal dung) and inorganic fertilizers, construction of a communal drain to reduce water logging and some limited land user rights, results show a tenfold increase in incomes, 20 percent decline in aggregate erosion levels and an increase in the dependence on livestock for dung manure, oxen draft, milk and cash. Moreover, a minimum daily calorie intake of 2000 per adult equivalent is met from on-farm outputs and per ha nutrient losses after intervention are reduced to -25 kg N, -14 kg P and -68 kg K on the average. There is hence a reduction in nutrient losses despite the higher reliance on the watershed for subsistence food requirements. The bias towards replenishment of nitrogen and phosphorous nutrients at the expense of potassium may, however, not be resolved. Emissions (leaching, gaseous losses, and erosion) could be higher than emissions (atmospheric deposition, nitrogen fixation) in both situations.

Soil losses are also compared under three scenarios: only modest chemical fertilizer application to achieve 1500 calorie consumption per adult equivalent; multiple technology intervention to achieve 1500 calories consumption and multiple technology intervention to achieve 2000 calorie consumption per adult equivalent. Security in land was assumed for the long term. Results showed that with multiple technological and policy interventions and consumption targets at 2000 calories per adult equivalent per day, soil losses are likely to be higher than those generated under the multiple intervention situation with a minimum calorie intake of 1500 per adult equivalent per

day. With limited intervention and a similar calorie intake of 1500, soil loss levels may be the highest. We may, therefore, conclude that when the set of multiple technologies are combined with a conducive policy environment such as a secure land policy, the result could be an outward shift of the watershed production possibility frontier that could enable higher outputs at lower biophysical and economic costs than before. The extent of this shift may however be reduced if self-reliance on food production for consumption at recommended levels is emphasized. Dependence on the market to meet some of the household food supplies, therefore, impacts positively on the sustainability of the watershed by enabling use of land based on land suitability and flow of outputs from surplus households to deficit ones through exchange. It also allows benefits related to the law of comparative advantage and the related economies of scale to be realized.

From a policy perspective, these results imply a need for a more secure land tenure policy than currently prevailing and provision of credit to ensure uptake of the above land management package. They also suggest a shift from a general approach to land management to a relatively more site-specific approach that emphasizes spatial and inter-temporal variability in input use based on land quality. Such variable rate technology is known to be an efficient nutrient management strategy as it enables farmers to apply optimal rates of fertilizer for each field and in each period. Moreover, residual nutrient loading is simultaneously reduced. Implementation of such a strategy may be difficult in a developing country situation but an attempt to do so may yield results that are significantly better than at present.

## **12. CREDIT POLICY AND INTENSIFICATION IN MIXED CROP-LIVESTOCK SYSTEMS: A MODELING PERSPECTIVE**

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Provision of credit to smallholder farmers is one strategy for promoting adoption of improved crop and livestock technologies. Governments have often used credit programs to promote agricultural output and credit policy could play a more efficient and equitable role in development if appropriate policies were adopted. However, advancing credit to smallholder farmers for encouraging technology adoption is a complex policy issue. Among the related issues are amount and form of credit, the interest charged, targeting of specific farmers' group and specific activities, and repayment schemes. The objective of this on-going research is to identify the appropriate credit policies for encouraging intensification. In this paper, we analyze the impact of advancing credit in kind in form of fertilizer on three groups of smallholder farmers with different levels of wealth.

The problem of land degradation is severe in the highlands of East Africa. Soil erosion and soil nutrient depletion are critical problems. Ethiopia is among the sub-Saharan Africa countries with the highest rates of soil nutrient depletion. FAO has estimated that one-half of the arable lands in the Ethiopian highlands are moderately to severely eroded. These problems are contributing to low agricultural productivity, poverty and food insecurity and malnutrition in the highlands. The technological response to soil erosion and nutrient depletion is adoption of effective erosion control

measures and improved soil fertility management technology, principally inorganic fertilizers. In the absence of technological response, smallholder, poor farmers respond by cultivating more land to compensate for low crop yields. As with the situation in the Ethiopian highlands, the high population growth shifts the demand for food outward. To respond to the increasing food demand, crop cultivation expands into pasture and steeply sloping marginal lands. The immediate consequence is further crop yield decline and rapid soil erosion rates. With the expansion of cropland, farmers need to keep more and more animals for traction, leading to higher animal population. Besides, the cultivation of pastureland reduces feeds available for livestock, where feed inadequacy leads to low milk yields, high young stock mortality, longer parturition intervals, and low animal weights. The consequences are poverty resulting from low crop and livestock productivity, malnutrition and food insecurity. Therefore, soil nutrient depletion, in low crop productivity, inadequate livestock feed availability and inadequate human nutrition are strongly linked.

The lack of adequate quality feeds is the major constraint to improving livestock productivity in the highlands of Ethiopia, mainly because of shortage of grazing land due to expansion of crop production on grazing area, lack of concentrates, and the generally low quality of available pasture. Despite recognition of this and the efforts to overcome it through feed research and development, progress in extending feed technologies, particularly forage crops, has been slow. This is principally because farmers cannot afford to allocate land to forage at the expense of food production. In modeling results for Selale, increased fertilization of barley, the major crop in the area, increased adoption of on-farm production of oats-vetch intercrops substantially. This suggests that

increasing land productivity with improved soil fertility management will ease the competition for land between food and feed crops since now higher output can be produced from the same or smaller land, freeing land for on-farm forage production.

Substantial evidence exists supporting the productivity and profitability gains from fertilizer application and intensification. With the increased use of mineral fertilizer during the 1995-96 and 1996-97 crop seasons, Ethiopia recorded its highest harvests of the major crops ever. Intensification also reduces the necessity of expanding cropping onto steep slopes and, thus, reduces erosion. Thus, intensification is a land-saving strategy and impressive savings similar to those that have accrued to China and India through application of modern technology to raise yields can be expected. Since improved soil fertility management enhances crop stands and vegetative growth, this will also enhance straw production for animal feeds, thus, improving animal productivity. Improving animal productivity will contribute to food security, better nutrition and increased incomes. Besides, availability of more manure will contribute to further improvement in soil fertility and structure.

However, adoption of intensive crop production technologies requires that inputs be available to farmers and that farmers can afford them, provided that these technologies are profitable. Farmers often lack financial resources to purchase inputs. A sound credit policy helps to alleviate this financial constraint either by providing inputs when credit is given in kind or allowing them to buy these inputs when cash credit is considered without constraining their consumption plans.

A mathematical programming household model was developed and applied to data collected from the Holetta area (located 40 to 70 km west of Addis Ababa) to model the

effect of credit on adoption of fertilizer technology. Substantial variability in crop allocation decisions exists among smallholder farmers. This variability is due to differences in level of resources such as land and labor, goals and needs. Moreover, the level of the farmer's wealth is among the important determinants of adoption of new technologies. As such, farmers cannot be treated as a homogenous group in predicting adoption and impact of new technologies. In this study, the Holetta sample farmers were disaggregated into relatively poor, medium and "rich" (by local relative standards) farmers taking into account livestock holding size, cropland area and family size as an indicator of labor availability. For each group, the impact of fertilizer credit is modeled. The model selects the cropping plan, the level of fertilizer used and the level of credit borrowed.

Because satisfying subsistence requirements of the household and production of sufficient quantities of straw are typically the principal objectives of the Ethiopian highlands smallholders, fertilizer credit is used by the three groups on the two major cereals: wheat and teff. In each case, the farmer borrows sufficient quantity of fertilizer for the entire area of these crops, according to the model results. However, the areas of these two crops differ between the three wealth groups and it is a function of total crop area of the household, available area and consumption requirements of the household (a function of family size). This scenario contrasts sharply with cropping allocation without credit where no fertilizer is used, according to modeling results. These results suggest that purchases of fertilizer compete unfavorably with consumption plans at planting time. Because of the low crop and livestock productivity caused by soil nutrient depletion, most farmers may have little food reserves and cash until next harvest. Some may need to sell some of their livestock. The last option was not included in this analysis.

The quantity of borrowed fertilizer is relatively small and ranges between 115 kg for poor farmers to 240 kg for rich farmers or Birr 207-431 worth of credit. The area fertilized is also relatively small, ranging from 0.9 to 1.87 ha with moderate rates of application. Nevertheless, the income effects were substantial. Poor farmers increase their income by 25 percent, while rich farmers increase their income by 57 percent. Moreover, application of fertilizer allowed substantial increases in the quantities of residues (straw) produced for livestock feeding, since fertilization also enhances the growth of the above-ground biomass.

The above analysis considers the effect of fertilizer credit advanced to smallholder farmers disaggregated by their wealth. The results support our hypothesis that credit will encourage intensification of the smallholder farming system of the Ethiopian highlands. This is expected to indirectly respond to the prevailing animal feed constraint. Based on this analysis and the empirical framework introduced, several hypotheses are formulated and will be tested in subsequent research:

1. Credit is an effective policy option to encourage adoption of intensive agricultural technologies.
2. Beside wealth, market participation is a major determinant of the amount of credit demanded by farmers. For example, credit demands of smallholder dairy farmers with crossbred cows are expected to be higher than subsistence farmers.
3. Intensification of crop and livestock reinforce each other, e.g., crop intensification allows market-oriented smallholder farmers to free some land

for on-farm production of fodder and feeds for their herds, which, in turn, leads to livestock intensification.

4. Since the conditions are already favorable for intensification in the highlands (population pressure and land scarcity), in-kind or cash credit will have the same effect, provided that farmers have access to these inputs.
5. Given the tendency for low crop prices immediately after harvest, the repayment terms of the credit are important in determining farmers' decisions regarding the amount of credit to borrow and the crops to produce.

### 13. DEVELOPMENT PATHS AND POLICIES FOR SUSTAINABLE LAND MANAGEMENT IN ANDIT TID, NORTH SHEWA: AN EXPLORATION

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#### INTRODUCTION

Andit Tid may be described as an area with low agricultural potential, good market access, and high population density. The high population pressure on the steep terrain has led to severe land degradation. We study the changes that have taken place over the last 15 years and look for policies that may be used to create incentives for more sustainable land use.

Our objectives are to:

- Analyze the current situation and recent trends in land use and household welfare in the study area,
- Assess key constraints to sustainable land management in the area,
- Present alternative policy options for discussion on how best to promote more sustainable land use and improve the welfare of farm households in Andit Tid and the Ethiopian highlands in general.

Andit Tid is located in North Shewa along the highway linking Tigray to central Ethiopia. It is a high altitude area (> 3000 m.a.s.l.). The land is located in two altitude zones: *dega* zone (< 3200 m.a.s.l.) and *wurch* zone (> 3200 m.a.s.l.). Most of the crop production takes place in the *dega* zone but barley is also grown in the *wurch* zone in the *belg* season (January to May). The two dominant soil types are *andosols* and *regosols*.

*Andosols* dominate in the *wurch* zone while *regosols* dominate in the *dega* zone.

*Andosols* are rich in organic matter. The grass turf is collected in heaps and burnt<sup>6</sup> before planting of barley. This releases nutrients for the crop but also causes considerable losses of organic matter and soil nitrogen. One estimate suggests 75 percent of the land to be on steep slopes (> 25 percent slope).

The main crop in the area is barley, followed by wheat, horse bean, and field-pea. Lentils and linseeds are also commonly grown. The average rainfall is 1336 mm per year distributed over two growing seasons. Droughts have not been common in the area until very lately when the *belg* rains have failed in three consecutive years. Hailstorms and frost have, however, commonly damaged crops. The farming system is a typical crop-livestock system where crop residues are used as animal fodder and animal manure is used for fuel or as manure on crops.

#### DEVELOPMENT PATHWAY 1980-2000

Changes in key variables are summarized in Table 1.

**Table 1: Changes in Andit Tid 1986-1999**

| <b>Variable</b>             | <b>1986</b> | <b>1999</b> |
|-----------------------------|-------------|-------------|
| Average farm size           | 3.77 ha     | 2.16 ha     |
| Average household size      | 5.04        | 5.67        |
| Average oxen holding        | 1.54        | 1.2         |
| Average number of cows      | 1.18        | 0.8         |
| Average number of sheep     | 6.25        | 5.3         |
| Cereal production           | Net sellers | Net buyers  |
| Tropical Livestock Units/ha | 1.48        | 1.71        |

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<sup>6</sup> Locally called *guay*.

We see a considerable decline in farm size, an increase in average household size, and decrease in livestock numbers per household but an overall increase in livestock population pressure. Only 5 percent of the fodder was obtained from communal land while 16 percent was purchased, making the farm itself the main source of animal fodder as well. A population growth of about 3 percent per year has contributed to the increasing land pressure that has caused an increase in cultivated area and reduction of fallow land area. Two percent of the land has degraded to badlands over two decades. Degraded land is used for grazing and tree planting. Crop yields have declined significantly. The recent droughts have caused an acute food insecurity problem and have converted the area to dependency on food aid. One third of the cereals consumed in 1999 were received as food aid.

#### KEY CONSTRAINTS TO SUSTAINABLE LAND MANAGEMENT (SLM)

- *Missing information:* Is lack of awareness about the problem or about solutions an important constraint?

Lack of awareness is probably not the problem due to the presence of the Soil Conservation Research Program since the early 1980s

The technical solutions provided to farmers appear to have been unattractive

- *Technology:* Do technological solutions exist and do they pay?

More sustainable technologies exist but

Conservation technologies are unprofitable, fertilizer use is risky, eucalyptus is profitable but appears to have a limited market

More research on technology options is required, emphasis should be given to fodder for improved livestock production and horticultural crops, and the potential complementary effects of combining fertilizers and conservation technologies

- *Tenure insecurity*: Is tenure insecurity reducing investment in conservation?

The 1997 land redistribution may have caused a reduction in number of households planting trees

Other constraints appear more important than tenure insecurity as constraints to SLM in Andit Tid

- *Resource poverty*: Are people too poor to conserve their resources?

Land scarcity appears to create incentives for farmers to remove conservation structures, to increase cultivable farm size, and to increase production in the short run

Poverty causes high discount rates and reduces incentives to invest in conservation

- *Market imperfections*: Do they prevent adoption of SLM and cause non-sustainable land use?

Imperfections in rental markets for land and oxen in Andit Tid appear to cause overstocking of oxen

Access to credit appears not to constrain fertilizer use; rather production risk and high fertilizer prices are limiting the use

- *Policy failures*: Have the past top-down policies undermined local participation and collective action and caused conservation technologies to be rejected?

Top-down implementation and choice of technology may be an important reason for rejection or removal of conservation structures in Andit Tid

It is uncertain whether a participatory approach would have been much more successful if it were to rely on the same technologies

## POLICY OPTIONS

- *Extension service: New roles:* Could the extension service become more active in promoting SLM, stimulate collective action, and improve the functioning of local markets?
- *New technologies:* More adaptive research is needed for high elevation areas like Andit Tid. The station should be used to test out new technologies, especially the potential of integrating conservation technologies and productivity increasing technologies.
- *Top-down policies vs. local collective action:* Assessment should be made of what the local people are able to do themselves with their own resources, what they can do with some assistance from the outside, and what they are unable to do and need more assistance for.
- *Land tenure policies:* Tenure security appears to be a necessary but not sufficient instrument to promote SLM.
- *Credit and input supply:* Care must be taken so that provision of credit and fertilizer does not become a substitute for conservation.
- *Pigouvian taxes and subsidies:* Taxes and subsidies may be used to internalize environmental externalities (e.g. land degradation). Taxes and subsidies may

be used on inputs as well as outputs. Careful analysis is required to do this properly.

- *Interlinkage of policies, markets and technologies:* Interlinked (“package”) approaches may be used to reduce transaction costs, address simultaneously several constraints, and improve targeting of policies. This is a knowledge demanding approach that must be fit to the local circumstances. Local participation and commitment is required in order for such policies to work.

*Examples:*

Linking (subsidized) input and credit supply to conservation requirements

Use Food-for-Work for conservation investment

Labor taxation (mobilization) for conservation investments

Tenure security linked to conservation requirements

Collective action to improve local markets

## CONCLUSIONS

Andit Tid has followed a Neo-Malthusian development path in the period 1980-2000. Reliance on market forces alone is insufficient to achieve SLM in this highly degraded area. Policies that attack the multiple constraints to SLM are required. Local participation is crucial for proper design, implementation, monitoring and enforcement of such policies.

## **APPENDIX A: WORKSHOP AGENDA**

### **POLICIES FOR SUSTAINABLE LAND MANAGEMENT IN THE HIGHLANDS OF ETHIOPIA**

International Food Policy Research Institute (IFPRI)  
International Livestock Research Institute (ILRI)  
Mekelle University (MU)  
Amhara National Regional Bureau of Agriculture and Natural Resources (ANRBANR)  
Oromiya Agricultural Development Bureau (OADB)  
Ethiopian Agricultural Research Organisation (EARO)

ILRI, Addis Ababa, May 22-23, 2000

#### **OBJECTIVES**

1. To familiarize key policy makers and other stakeholders in Ethiopia with the objectives and activities of the project.
2. To review the progress and findings of the project so far.
3. To consider key policy issues affecting the prospects for sustainable land management in the highlands of Ethiopia.

AGENDA

**Monday, May 22, 2000**

*Session 1: Opening*

**Chairperson: Dr Mitiku Haile, President, Mekelle University**  
**Rapporteur: Mohammed Ahmed**

- 9:00 Welcome and introduction..... *Simeon Ehui, ILRI*
- 9:15 Welcome address ..... *Peter Hazell, IFPRI*
- 9:20 Opening of Seminar ..... *Ato Belay Ejigu, Vice Minister of Agriculture*
- 9:30 Project objectives, activities and organization..... *John Pender, IFPRI*
- 9:45 Questions/clarifications

*Session 2: Land Management in the Amhara Region*

- 10:00 Land management issues in the Amhara region ..... *Lakew Desta, ANRBANR,*  
*Samuel Benin, ILR*
- 10:30 Questions/discussion
- 10:45 Coffee/photograph

*Session 3: Land Management in the Tigray Region*

**Chairperson: Dr Belay Demisse, Head, ANRBANR**  
**Rapporteur: Mohamed Ahmed**

- 11:15 Community resource management: Management of  
woodlots and grazing areas in Tigray..... *Berhanu Gebremedhin, ILRI*
- 12:00 Questions/discussion
- 13:00 Lunch
- 14:00 Land management in the Tigray region: Causes and implications *John Pender, IFPRI*

- 15:00 Questions/discussion  
15:30 Coffee
- 16:00 Small scale irrigation systems in Tigray region:  
Potentials and problems .....*Girmay Tesfay, MU*
- 16:30 Questions/discussion
- 17:00 The role of trees for sustainable land management in less-favored lands:  
The case of eucalyptus in Ethiopia .....*Pamela Jagger, IFPRI*
- 17:30 Questions/discussion
- 18:00 End of first day

**Tuesday, May 23 2000**

***Session 4: Land Management in the Oromiya Region***

*Chairperson: Dr Tenkir Bongor*  
*Rapporteur: Berhanu Gebremedhin*

- 09:00 Nature and causes of land degradation in the  
Oromiya region.....*Bezuayehu Tefera, OADB, Gezahegn Ayele, EARO*
- 09:30 Questions/discussion

***Session 5: Modeling the Impact of Alternative Technologies and Policies***

- 10:00 Technology and policy impacts on nutrient flows, soil erosion and  
economic performance at watershed level:  
Application of a bioeconomic model.....*Mohammad Jabbar, ILRI*
- 10:30 Questions/discussion
- 11:00 Coffee
- 11:20 Modeling the impacts of credit and land constraints ..... *Mohammed Ahmed, ILRI*
- 11:50 Questions/discussion

12:15 Options for sustainable land management in the Amhara region—  
A case study of Andit Tid .....*Stein Holden, Agricultural University of Norway*

12:45 Questions/discussion

***Session 6: General Discussion***

13:15 Review and discussion of key policy issues  
arising from the study ..... *Simeon Ehui*

14:00 End of workshop.

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## List of EPTD Workshop Summary Papers

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