

Policies for sustainable land management in the highlands of Ethiopia

Socio-economics and Policy Research Working Paper 30



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Summary of papers and proceedings of a seminar held at the International Livestock Research Institute, Addis Ababa, Ethiopia, 22–23 May 2000

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ISBN 92–9146–088–5

Correct citation: Jabbar M.A., Pender J. and Ehui S.K. (eds). 2000. *Policies for sustainable land management in the highlands of Ethiopia: Summary of papers and proceedings of a seminar held at ILRI, Addis Ababa, Ethiopia, 22–23 May 2000*. Socio-economics and Policy Research Working Paper 30. ILRI (International Livestock Research Institute), Nairobi, Kenya. 68 pp.

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Acknowledgements

The Swiss Agency for Development Co-operation is funding the project's activities in the Tigray region and partly in the Oromiya region; the Foreign Ministry of Norway is funding the activities in the Amhara region; and the International Livestock Research Institute (ILRI) is providing core funds in all the regions. A United States Agency for International Development (USAID) small grant has allowed some aspects of the project to be linked with Purdue University, USA. The University of Manchester, UK, has also contributed through partial support of a graduate student.

All the collaborating partners in the Amhara, Oromiya and Tigray regions are contributing through secondment of staff and provision of other in kind contributions (e.g. office space, and administrative and logistical support) for implementation of activities in the respective regions.

We are grateful to all the donors and partners for their support. The ILRI Publications Section deserves thanks for editorial assistance and printing the document.

This document has also been released as an IFPRI publication (Environment and Production Technology Division (EPTD) Workshop Summary Paper 9. IFPRI (International Food Policy Research Institute), Washington, DC, USA).

Welcoming address

S. Ehui

Co-ordinator, Livestock Policy Analysis Programme
International Livestock Research Institute (ILRI), Ethiopia

Your Excellency Ato Belay Ejigu.

Vice Minister of Agriculture of the People's Democratic Republic of Ethiopia.

Prof Mitiku Haile, President, Mekelle University.

Distinguished Representatives of the Regional Governments of Amhara, Oromiya and Tigray.

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 seminar 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 Prof Mitiku for successfully leading Mekelle University College into a full university status 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 travelled long distances by bus to attend this seminar 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 centres 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, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (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 organisations. 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-organised its research into eight major programmes and four production-to-consumption projects to address the multiple challenges these developments pose to research. These programmes 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 the 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 rain-fed lowland regions in South-East Asia.

The goal of the Policy Programme of ILRI, which I have the honour 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 IFPRI whose mission is to identify and analyse 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 characterised by low agricultural productivity, poverty and land degradation. Grain yields are less than two tonnes per hectare and a large proportion of the rural population live in absolute poverty. The

highlands of Ethiopia are also characterised by severe land degradation where mining of 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 liberalisation and input supply policies to name but a few.

To address these problems, a regional (East Africa) workshop was organised during February 1997. This was followed by three workshops in Ethiopia: 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 the United States Agency for International Development (USAID) and are still looking for funding to support additional activities in the Oromiya region. I am especially pleased that Dr Mauro Ghirotti of the Italian Development Co-operation is participating in this meeting as we are negotiating possible funding from them. We thank all the donors for their 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 seminar are to:

- familiarise 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
- 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.

Welcoming address

P. Hazell

Director, Environmental and Production Technology Division
International Food Policy Research Institute (IFPRI), USA

Honourable Vice Minister, friends and colleagues.

On behalf of IFPRI, I warmly welcome you all at the seminar.

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 seminar.

This project on 'Policies for sustainable land management in the highlands of Ethiopia' 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 Organization (EARO) in implementing this research project. I hope that the participation of all of those present at the seminar will help us understand the land degradation problems and potential solutions better. We are looking forward to a fruitful discussion.

Opening address

Belay Ejigu

Vice-Minister, Ministry of Agriculture
Government of the People's Democratic Republic of Ethiopia

Distinguished guests!

Seminar participants!

Ladies and gentlemen!

It gives me a great pleasure and honour 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 ongoing 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% of Ethiopia's farmers, over 95% of the cropped area, around 66% of its livestock, almost 50% of its land area and over 90% 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 tonnes/hectare (t/ha) per year on currently cultivated lands and 70 t/ha 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 are important problems, 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 individuals 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 small holdings 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 the opportunity to recommend this august body: to look for ways and means: of increasing investment opportunities and capacity of the research and extension system; to recognise the need for greater integration of productive technologies with efforts to conserve soil and water; 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, and discuss and consider key policy issues, which will lead to the prospect of 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!

Policies for sustainable land management in the Ethiopian highlands: Project objectives, activities and organisation

J. Pender

International Food Policy Research Institute, USA

Motivation for project

- Severe interrelated problems of low agricultural productivity, land degradation and poverty in the Ethiopian highlands.
- Cereal yields less than 1 tonne/hectare (t/ha) are common.
- Evidence of severe soil erosion and soil nutrient depletion.
- Most farmers surviving with less than 1 ha of land and incomes less than US\$ 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 and 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 and deforestation.
 - Key policy issues identified: impacts of land policies, market policies, infrastructure, research, extension, conservation measures and decentralisation/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 socio-economic and policy research related to sustainable land management in the region.

Activities

- Problem characterisation and generation of hypotheses—literature review, consultations, field visits and evaluation of 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, and the National Advisory Committee.
- Capacity strengthening activities—including involvement of collaborators in research and publications, support to Ethiopian graduate students, training workshops etc.

Organisation

- Overall project leadership and co-ordination: IFPRI and ILRI
- Tigray
 - Leadership: IFPRI, ILRI, Mekelle University
 - Collaborators: Tigray Bureau of Agriculture and Natural Resources, Tigray Bureau of Planning and Economic Development, and others
- Amhara
 - Leadership: IFPRI, ILRI, Amhara National Regional Bureau of Agriculture and Natural Resources, and the Agricultural University of Norway
 - Collaborators: Amhara National Regional Bureau of Planning and Economic Development, and others
- Oromiya
 - Leadership: IFPRI, ILRI, Oromiya Agricultural Development Bureau, Ethiopian Agricultural Research Organization, Purdue University (USA) and Manchester University (UK)
- Linkages to other international research programmes and similar IFPRI-led research in Uganda:
 - African Highlands Initiative
 - Soil, Water and Nutrient Management Programme
 - ASARECA/ECAPAPA (Association for Strengthening Agricultural Research in Eastern and Central Africa/East and Central Africa Programme on Agricultural Policy Analysis)
 - IFPRI 2020 Vision Policy Research Network for East Africa
- Financial support: Switzerland, Norway, Italy, USA, IFPRI and ILRI core resources

Executive summary

J. Pender^a and S. Ehui^b

a. International Food Policy Research Institute, USA

b. International Livestock Research Institute, Ethiopia

[Overview of papers](#)

[Overview of discussions](#)

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Overview of papers

The papers presented at the seminar provided a great deal of information about: the interrelated problems of land degradation, low agricultural productivity and poverty in the Ethiopian highlands (emphasising 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 Hagos et al. 1999; Lakew Desta et al. in this working paper; Bezuayehu Tefera et al. in this working paper). The proximate causes of these problems include soil characteristics (such as its inherent erodibility and infertility), intense and erosive rainfall periods, the steep and dissected terrain in the highlands, deforestation, overgrazing, cultivation on steep slopes, frequent ploughing, 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 fertilisers. Many factors are hypothesised 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 liberalisation, land policies, infrastructure investment (especially in roads and irrigation systems), agricultural research and extension policies, resource conservation programmes and policies, input and credit supply policies, education policies, and policies to promote decentralisation and development of local organisations.

The challenge for policy makers is to identify and implement appropriate combinations and sequences of policies and programmes 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 major 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 with 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 emphasised conservation based agriculture led industrialisation, through liberalisation of markets; decentralisation of planning and resource management; widespread investments in improved infrastructure, education, health facilities and other public services; an emphasis on community resource conservation and management through establishment of community woodlots and enclosed areas; promotion of private adoption of resource conservation measures; promotion of use of improved agricultural inputs, such as improved seeds and fertiliser and availability of short-term agricultural credit; and promotion of development of farmer organisations and other local organisations. 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 seminar, particularly for Tigray (where the research project is most advanced).

Based on analysis of the Tigray community survey, Pender et al. (in this working paper) found that there has been broad improvement in access to infrastructure and public services (e.g. roads, irrigation, schools, health facilities, extension services and 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 fertiliser, 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 (1998) for which recent yield data were collected; however, 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 with 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 Tesfaye et al. in this working paper). 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 (Girmay Tesfaye et al. in this working paper).

Road development has also contributed to changes in farming systems, shifting production away from cattle and towards cash crops (Pender et al. in this working paper). 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 Gebremedhin et al. paper on woodlots, in this working paper) but with mixed effects on collective action to manage grazing lands (Berhanu Gebremedhin et al. paper on grazing lands, in this working paper).

The extension and credit programme 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 programme 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 labour and capital intensification of agriculture in Tigray (Pender et al. in this working paper). 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 (Pender et al. in this working paper). This is consistent with the finding of Berhanu Gebremedhin et al. (grazing land paper, in this working paper) that violations of use restrictions on grazing land were more common at high (greater than 200 persons/km²) than at intermediate (between 100 and 200 persons/km²) population densities. Collective action in managing community woodlots was also found to be more effective at intermediate than high population densities (Berhanu Gebremedhin et al. woodlot paper, in this working paper).

Collective action to manage woodlots was found to be less effective for woodlots that were promoted by an external organisation (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 (Berhanu Gebremedhin et al. woodlot paper, in this working paper). 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 organisation. 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 in the discussion by officials from Tigray, 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 in this working paper).

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 Desta et al. in this working paper) 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 in this working paper). 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 minimised 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 run-off, 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 there yet. 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 (Fitsum Hagos et al. 1999; Lakew Desta et al. in this working paper). Thus we expect similar responses and implications from these areas, though this hypothesis cannot be tested until the data from the Amhara survey are analysed.

Data from one village in the lower potential part of south-eastern 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 Bekele Shiferaw in this working paper). 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 Desta et al. in this working paper; Bezuayehu Tefera et al. in this working paper). Detailed data collection and bio-economic modelling 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. in this working paper). 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 fertiliser, 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 (emphasising 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 bio-economic 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 in this working paper).

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, inter-linking 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 in achieving the potential for more rapid and sustainable development.

Overview of discussions

The discussions of the papers and issues among seminar 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 summarise 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 emphasised 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 emphasised in the presentations. One participant argued that the types and evolution of farming systems should be taken as an organising 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 considered 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 recognised 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 micro-dams 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 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 was 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 trade-offs 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 term, 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 organisation and social capital. Local land tenure institutions, organisations, religion, labour mobilisation 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 analysed. It will be easier to assess the impacts of some of these factors (such as religion and organisations) 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.

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(All other references are papers included in this document.)

Land degradation in the highlands of Amhara region and strategies for sustainable land management¹

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1. The full paper is forthcoming in the Socio-economics and Policy Research Working Paper series, ILRI (International Livestock Research Institute), Nairobi, Kenya.

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Introduction

This document summarises results of the preliminary phase of the research project to characterise the nature and causes of land degradation in the highlands of the Amhara region and to examine the opportunities for more sustainable land management and development. The preliminary phase was 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 was to draw upon what was already known about the problems 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 major objectives of the community survey are to identify the dominant pathways of development.² in the region and to suggest hypotheses about their causes and implications for agricultural productivity, sustainable land management and poverty. The hypotheses formulated will be tested using data collected in subsequent household- and plot-level surveys.

2. 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.

Land degradation in Amhara region

Amhara National Regional State is located in the north-western part of Ethiopia between 9°N. 13°45. N and 36°E. 40°30. E, with a total area of 170,152 km². Of the total area, cultivation and grazing land make up 30% each. Forest, shrub, bush and woodland, bodies of water and wasteland make up 17%, 4% and 16% of the total area, respectively, and the remaining 3% is taken up by settlement. The total regional population is about 14.4 million, with an average land holding of 1.7 hectares. About 35% of the nation's livestock population is found in the region, with the major 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 Soil Conservation Research Project (SCRIP) stations in the region showed soil loss rates between 0.04 and 212 tonnes/hectare (t/ha) per year. About 29% of the total area of the region experiences high erosion rates (51. 200 t/ha per year); 31% experiences moderate erosion rates (16. 50 t/ha per year); 10% experiences very high erosion rates (>200 t/ha per year); and the remaining 30% experiences low erosion rates (<16 t/ha per year).

Nutrient depletion. Loss of fertility is manifested through limited recycling of dung and crop residues in the soil, low use of chemical fertilisers, declining fallow periods, soil and organic matter burning, and soil erosion. Although the farming system in the highlands of Amhara is primarily mixed crop. livestock, nutrient flows between the two are predominantly one sided, with feeding of crop residues to livestock but little or no dung returned to the soil. For example, UNECA (1996) data show that even though almost all households (90%) fed crop residues to their livestock, only 40% 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 billion tonnes 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. Factors 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 programmes, land use regulation, local governance and collective action, and non-governmental programmes.

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 labour intensity of agriculture through the land:labour ratio and may also induce innovations in technology, markets and institutions, or investments in infrastructure; and, thus, it affects the comparative advantage of labour intensive strategies of development. These three factors interact with each other in complex ways, and we can classify the highlands of Amhara into eight major types, considering two levels (high and low) of each factor. The hypotheses about what opportunities exist in each situation are shown in Table 1.

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

Agricultural potential	Market access	Population density	
		High	Low

High	High	High input cereals Perishable cash crops Dairy, intensive livestock Rural non-farm development (20; 557)*	High input cereals Perishable cash crops Dairy, intensive livestock Livestock and grazing improvement Rural non-farm development (12; 405)
	Low	High input cereals Non-perishable cash crops Bee-keeping (6; 192)	High input cereals Non-perishable cash crops Livestock and grazing improvement Bee-keeping (4; 71)
Low	High	Low input cereals Rural non-farm development (14; 354)	Low input cereals Livestock and grazing improvement Woodlots Rural non-farm development (7; 220)
	Low	Low input cereals Bee-keeping Migration (2; 65)	Low input cereals Livestock and grazing improvement Bee-keeping Migration (10; 274)

* The figures in parentheses show the number of rural *weredas* and rural *kebeles*, respectively, which fall in each category.

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 products. There is also strong potential for rural non-farm development linked with 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, and input and output marketing systems will be critical to the success of these pathways.

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 fertiliser). This may require subsidising 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 realised.

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 are likely to be important. Bee-keeping 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 migration 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.

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Community natural resource management: The case of woodlots in northern Ethiopia

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Introduction

Common property resources¹ 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 organisations 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 organisations 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.

1. 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.

The Tigray region is located in northern Ethiopia on the Sudano-Sahelian dry lands zone. More than 80% 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 highlands² 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.

2. Highlands are defined as those areas >1500 m above sea level.

The factors used to explain variations in collective action included population density, access to market, agricultural potential, the presence of external organisations, 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 labour contribution per hectare (ha) invested in managing the woodlots, whether there were any violations of use restrictions of woodlots, whether the community pays for a guard to protect the woodlot, the number of trees planted per ha on the woodlot since establishment and the survival rate of the trees planted.

Results

Almost 90% 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 organisation, 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. 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 included 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 tended to use a more intensive management strategy. Woodlots contribute, on average, more than 5 million Ethiopian birr (EB; US\$ 1 = EB 8 in 1998) per community to community wealth.

Multiple regression analysis to explain the labour intensity of woodlot management, whether the community pays for a guard, whether any violations of use restrictions occur and the survival rates of trees supports the hypothesis of an inverted U-shaped relationship between collective action and population density (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 labour input, plant trees more densely and achieve higher tree survival rates, perhaps because the opportunity costs of labour or the opportunities to escape community sanctions for non-co-operation are less further from markets. The presence of external organisations was negatively associated with whether the community pays for a guard, since external organisations often pay for the guard. The presence of external organisation was also negatively associated with tree survival, suggesting that external programmes 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 labour 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.

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 grazing lands would result in overexploitation of the resource. Community grazing land management is being recognised as a viable alternative to privatisation or state ownership and regulation to reduce the problem of grazing land degradation. However, there is a paucity of evidence regarding the nature and effectiveness of local level institutions and organisations for grazing land management in developing countries. This paper seeks to contribute to this gap in 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 in northern Ethiopia and covers an approximate area of about 80 thousand km². More than 80% 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

Results are based on data collected during the 1998-99 cropping season by a survey of 50 *tabias* (the lowest administrative unit in Tigray usually consisting of 4-5 villages) and 100 villages in the highlands¹ of Tigray. A semi-structured questionnaire was administered in a group interview with community representatives at *tabia* and village levels. Data were 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.

1. Highlands are defined as those areas >1500 m above sea level.

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 land and presence of external organisations. Collective action to manage grazing lands and its effectiveness were measured in terms of whether a community had 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 penalised when they occurred.

Results and conclusions

Restricted grazing areas are common in Tigray. Every village has some type of grazing area and 74% of the surveyed villages had restricted grazing areas, with an average area of 24 ha/village. Most restricted grazing lands were not promoted by external organisations. Only about 17% 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 were managed at the village level. The regional Bureau of Agriculture and Natural Resource Development (BoANRD) provided technical advice and material support. The most common contribution by village members in managing the grazing lands was a cash or in kind contribution for guard payment. Communities tended to use stricter penalties when violations of use restrictions were 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 between collective action and population density, 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 favour collective action for grazing land management while the presence of external organisations tend to retard it. These results suggest that community grazing land management can contribute to a more sustainable use of grazing lands and, under the right circumstances, the alleviation of feed shortage problems. Public intervention in grazing land management needs to be complementary to local efforts.

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, northern Ethiopia, 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 the 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 greatest in areas that were less favoured in 1991, helping to equalise access across 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 labour 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 programme appears to have effectively promoted more intensive land management and conservation practices, contributing to higher crop yields, and 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 Development (BoANRD) 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, favouring production of perishable cash crops as well as non-farm activities as sources of cash income rather than ruminant production. Irrigation has contributed to intensified land use and to changes in crop choice but has been associated with less adoption of fertilisers 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. These options may include increasing the priority of extension activities in irrigated areas and increasing the 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) towards 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 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 labour 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 fertilisers 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. Realisation 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 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.

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 industrialisation and food security strategy of the Ethiopian Government. Increased availability of irrigation and less dependency on rain-fed 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 stabilise 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 micro-dams and river diversions have been built or rehabilitated. Other non-governmental organisations and communities are also undertaking water resource development activities with the same objective. Besides development of new schemes, some traditional systems are also being 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 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 labour 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 tries to assess the status of irrigated agriculture development in Tigray and to identify the major management and institutional issues which are worthy of further consideration.

Methods

The results are based on data collected in two separate surveys: a survey on land tenure issues in small-scale irrigation development in Tigray conducted in 1999–2000; and a community-level survey on land management conducted in 1998–99. The former survey covered seven selected irrigation sites, including both traditional and newly constructed irrigation schemes. The community survey also covered experiences relating 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 thousand km². It has a population of more than 3.3 million and an annual population growth rate of 3%. 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 of the region the major rainy season (locally called *kiremti*) lasts for 3 to 4 months, between June and mid-September. The mean annual rainfall ranges from 980 mm on the central plateaux to 450 mm on the north-eastern escarpments of the region. The annual rainfall shows a high degree of variation with a coefficient of variation ranging from 20% in western to 49% in eastern parts of Tigray. Temperature ranges depend on altitude and vary 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 south west to 25°C in the extreme eastern areas.

The economy of Tigray is entirely dominated by peasant agriculture involving traditional methods of crop production and livestock rearing. Agriculture accounts for 64.5% of the regional gross domestic product. However, the annual growth rate of production is only 1.2%, which is below the national average, while population is growing at 3% per annum.

The water resource of Tigray is not well studied. Available studies indicate that only about five perennial streams have flow rates of more than 10 litres/second. The loss of water through the three major drainage systems of the region during the annual rainy season is immense. In total through the Tekeze, Mereb and Dennakil basins 9 billion cubic metres of water goes from Tigray to neighbouring countries every year; this is almost equivalent to the 9.21 billion cubic metres of the total estimated rainfall in the region. If 50% of the 9 billion cubic metres of runoff was used, 500 thousand hectares (ha) of land, which could feed three-times the present population of Tigray, could be irrigated. Thus, water harvesting and management practices are of paramount importance so that excess water can be stored and used later for irrigation and other purposes. In Tigray, the estimated irrigation potential is 324,286 ha; currently, only 15,495 ha are irrigated, mainly through traditional practices. Large-scale water resource development has not yet started.

Irrigation systems

Although there is inadequate documented evidence regarding the history of irrigation practices in Tigray, some evidence dating back to 500 BC indicates that irrigation was practised in the ancient village of Yeha in Adwa and some other places. Descriptive data from the 50 communities surveyed indicate that 49 of the communities have access to two or three minor irrigation sources. Data also indicate that 90% of the micro-dams and 62% of the introduced river diversions were constructed after 1991.

In Tigray, surface irrigation is the predominant form of irrigation; it includes spring development, river diversion, flood spreading, micro-dams 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.

Study results indicate that within the communities surveyed, a total area of 1895 ha is irrigated using spring systems. Moreover, 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 micro-dam systems. The significance of the pump and pond system is, however, not well known.

Results of the descriptive analysis indicate that there are a few cases in which farmers encounter minor problems of farmland loss, conflict over access to irrigation or increased incidences of diseases and pests. In the majority of irrigation systems these problems are almost non-existent. However, some of these problems evolve over time and their absence currently does not mean that 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 were identified as being worthy of further consideration to ensure the effectiveness of irrigation development in Tigray:

- Economics of small-scale irrigation in Tigray are not well understood. Economic evaluation of optimal plot size, cropping patterns, technologies, agronomic practices and resources utilised in the irrigation schemes is necessary.
- Small-scale irrigation systems are often scattered widely and thus the provision of inputs, services and technical advice may be difficult given the poor infrastructure. Involvement and co-operative effort of beneficiaries are required.
- Local communities are playing major roles 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 in development of irrigation 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 by institutional changes. Lack of viable product markets and marketing institutions are major problems. Government and other institutions should focus on overcoming marketing problems.
- Rural credit systems should encourage adoption of available low-cost technologies.
- Promotion of complementary enterprises should be given due attention, so as to optimise the efficiency of irrigation systems.
- The relationship between water rights and rights to land is not clear in Tigray. It requires clarification so that expensive irrigation water can be utilised properly.
- In water resource development, harmonisation of the different demands for water, establishment of irrigation priority rights between upstream and downstream users, and consideration of 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. Currently, local communities resolve the matter through their community norms; however, it requires a formal institutional approach based on local experience.
- A comprehensive irrigation policy which clarifies 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 finalised and implemented.

Conclusions and implications

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

The role of trees for sustainable management of less favoured 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 practising subsistence agriculture on less favoured 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 increase farm incomes, reduce poverty, increase food security and diversify smallholder farming systems in less favoured areas of northern Ethiopia.

Despite the potential for eucalyptus to improve rural livelihoods, since 1997 the Regional Government of Tigray has imposed a ban on eucalyptus tree planting on farmlands. The ban is a result of the government wanting to ensure that farmlands are utilised 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 m³ compared with 1.2 m³ 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. Furthermore, 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 to 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 m away from where eucalyptus trees are planted. The long-term and broader hydrological impacts, including down-stream effects of wide-scale eucalyptus planting are not known. Finally, the species of eucalyptus commonly grown in Ethiopia (*Eucalyptus camaldulensis* and *E. globulus*) are drought, flood and fire resistant, and are not currently threatened by pests.

Because smallholders and communities make land use decisions based upon socio-economic criteria as well as potential ecological implications, it is important to consider the economic conditions that facilitate tree planting. We hypothesise 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 minimised (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 baseline scenario, we estimate a minimum IRR of 19% 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 tree 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% 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 5 years yields *ex ante* IRR as high as 173% and lengthening the rotation age to 15 years yields IRR as low as 10% for *tabia* managed woodlots. Our third scenario, addresses the issue of potential crop production losses. Estimates indicate that even a 100% crop production loss in an area extending 10 m from a 1 ha woodlot results in only 4–6% 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 localised 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
- privatising 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
- 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 favourable ecological implications, is to allocate community wasteland for private tree planting. If the estimated 334 thousand ha of wasteland in Tigray were planted to eucalyptus at the median planting density of private woodlots (approximately 3000 trees/ha), 70% of the trees survive and trees worth 17 Ethiopian birr (EB; US\$ 1 = EB 8 in October 1999), a conservative estimate based upon our price data, are harvested every 10 years, the annual increase in income would be more than 370 EB/capita (almost half of the 1998 Ethiopian gross domestic product/capita) if we

assume a relatively elastic and stable market for woodlot products. Assuming a 10% social discount rate, the net present value of this investment would be about 2000 EB/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 localised management of community woodlots is also a favourable policy option that could be considered. More localised management is likely to: increase returns to woodlot investments; improve food security through income generation; and improve environmental sustainability by providing woody biomass for fuel, replacing or substituting the high proportion of dung and crop residues currently utilised for fuel in Tigray. Allowing the planting of eucalyptus on farmlands also offers substantial benefits; however, there are much greater costs (i.e. opportunity costs) and environmental risks. Moreover, 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 emphasis of the importance of planting indigenous trees as well as fast growing exotic species, would be complementary to all policies.

Nature and causes of land degradation in the Oromiya region: A review of literature

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[Causes and effects of land degradation in Oromiya](#)

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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 its causes, and to development of hypotheses about possible pathways to intensify agriculture in a sustainable way. These hypotheses will be tested with field data collected at later date.

Oromiya is located in the central part of Ethiopia extending from 3°20'N to 10°35'N and from 34°05'E to 43°11'E, with a total land area of 353,690 km². It constitutes about 31.2% of the total land area of the country, making it the largest of the 14 regions of Ethiopia.

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 4300 m above sea level, with the highlands constituting about 48% of the region's area. Mean annual temperature ranges from 10°C to 22°C in the highlands¹ and from 22°C to 30°C in the lowlands. Annual average rainfall in the region ranges from 200 to over 2100 mm.

1. Highlands are defined as those areas >1500 m above sea level.

The total human population in the region was 20.5 million in 1998 and has an annual population growth rate of 3%; the livestock population is estimated to be about 18.7 million tropical livestock units (TLU). The highlands host more than 80% of the total human population and 70% of the livestock population in the region and account for over 90% of the cropland. Almost 90% of the economic activities of the region 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 (h) for 5 minutes (min), 3.6 cm/h for 15 min, 2.5 cm/h for 30 min, or 2.0 cm/h for 60 min 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% 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 tonnes/hectare (t/ha) per year, while soil loss rates range from 51 to 200 t/ha per year (dominantly from 51 to 100 t/ha) in some parts of Sidamo and the Bale highlands, and from 100 to 200 t/ha per year on sloping cultivated land in parts of Illubabor.

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 are becoming serious problems in Oromiya, especially in the rift valley and associated lowlands. Recent estimates indicate that 3.1% of the natural forests in Oromiya are lost annually. A study in three Peasant Associations (PA) of Adaba and Dodola (Bale zone) during 1993–97 showed that the annual rates of deforestation were 1.6%, 9.4% and 5.6%, respectively. Another study conducted during 1996–98 in the Belete forest and the Gera forest of Jimma zone showed that the annual rates of deforestation were 9.5% and 4.7%, 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 the 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 (runoff = 437 vs. 112 mm) under the same slope conditions (both gradients = 18%). Forest coffee on much steeper slopes (gradient 51%) showed the least runoff throughout the test period, with a maximum of only 36 mm. Over 81% 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 22.6 to 28.5 million giga joules (GJ) of energy from animal dung is used for fuel in the region each year. Use of dung as fuel means denying the soil of this effective conditioner and fertiliser. This practice is most pronounced in areas where forest cover has more or less disappeared and where an acute fuel shortage is occurring, 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 mineralisation is high in the absence of natural cover, as when topsoil is exposed to unusual extremes of temperature and humidity. There is evidence that soil organic matter content increases as the length of fallow period increases, whilst it decreases as cultivation period becomes longer. In the Metu area, Illubabor zone of

the Oromiya region, soil organic matter content decreased from 20% to 7% in less than 3 years of continuous cultivation as a result of mineralisation.

- About 52% of the total land in the crop–livestock system of the highlands is used for grazing and browsing. 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%) 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 mid-land Chiro, eastern Oromiya, despite a guideline to cultivate only lands with slopes with gradients below 35%, increased population pressure has forced farmers to cultivate areas with gradients of 50%, thereby contributing to the degradation process. In Melkedera PA of Ambo *wereda* in Oromiya, population increased by 25% between 1984 and 1994. Moreover, resettlement in 1984–85 is reported to have increased the population of Sor *awraja*, Illubabor, by up to 12%, leading to pressure on land and its quality.
- In some parts of the region, increasing population pressure has led to fragmentation of land and intensive cultivation without better quality inputs and this has led to degradation. A study in Dizi catchment in the Metu area showed that in 1957 and 1982, respectively, the amount of cultivated land was 30% and 41% of total area or 38% and 51% of the land available for cultivation, causing the crop:fallow cycle ratio to decrease from about 1:2 to 1:1 over this period. About 29% of the families in Ambo *wereda* do not have access to land, while at least 30% 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.
- People's level of poverty also determines their behaviour in terms of conservation or degradation of natural resources. For instance, due to the increasing poverty in Melkedera PA in Ambo *wereda*, reliance on off-farm activities including marketing forest products has become common practice for the people. A forest dependency survey conducted in the area showed that 22% and 33% of the households in the PA are occasional and regular dependents on forest, respectively, for their livelihoods.

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 in land, and hence better management of land including use of appropriate technologies are positively related. Land tenure security has been poor generally under all the three political regimes in recent periods: the feudal, Derg and current regimes. During the feudal period, the Emperor 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 have been frequent redistributions by the government to accommodate new families. For instance, in Tiyo *wereda*, there have, on average, been 3.5 land redistributions per household while 17% 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 in the region is not very long. Moreover, research and extension activities throughout the past periods have concentrated on crop improvement and productivity increasing technologies and inputs. Conservation per se has received little attention. Also, research and extension have

served the large-scale private and state-owned commercial farms rather than the smallholder sector. Consequently the vast majority of smallholder farms has benefited very little from research and extension programmes. Some efforts have been made by both government and development agencies to introduce conservation technologies but these technologies were not sustained once the outside initiatives 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% 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 major 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 agro-ecological zones: a high potential cereal zone, a low potential cereal zone and a perennial zone. Vertisol soils are a major land resource in the high potential cereal zone but major constraints in this zone are 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 agro-ecological zone has domains with a combination of population density and market access gradients, which also define opportunities and constraints. Therefore a diversity of situations exist in the region requiring identification of different sets 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 a 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.

Technology and policy impacts on nutrient flows, soil erosion and economic performance at watershed level: Application of a bio-economic model

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[Background](#)

[Bio-economic model results](#)

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 a 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 minimisation of external inputs use and maximisation of their efficiency, this study utilises 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 a reduction in nutrient losses or an increase in nutrient gains are explored.

Cross-sectional socio-economic and biophysical data from four land categories found in the Ginchi 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.

Bio-economic model results

Two versions of the bio-economic model are generated; a static goal programming version; and a dynamic non-linear mathematical programming version. The static goal programming approach simultaneously optimises both environmental and economic goals of the watershed and its results are used to validate the dynamic model. The dynamic model optimises 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 fertiliser. Both versions of the model take into account seasonality in input and output supplies, labour 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 12-year planning period, incomes increase by 50% from a very low base and average per hectare (ha) soil nutrient balances stand at -58 kg for nitrogen, -32 kg for phosphorous and -114 kg for potassium. Associated soil losses are 31 tonnes/ha. With a set of new technologies involving use of new high yielding crop varieties, agroforestry, organic (animal dung) and inorganic fertilisers, construction of a communal drain to reduce water logging and some limited land user rights, results show a 10-fold increase in incomes, 20% 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 interventions are reduced to -25 kg nitrogen, -14 kg phosphorus and -68 kg potassium on 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 imissions (atmospheric deposition and nitrogen fixation) in both situations.

Soil losses are also compared under three scenarios: only modest chemical fertiliser application to achieve a consumption target of 1500 calories/adult equivalent per day; multiple technology intervention to achieve a consumption target of 1500 calories/adult equivalent; and multiple technology intervention to achieve a consumption target of 2000 calories/adult equivalent. Security in land was assumed for the long-term. Results showed that with multiple technological and policy interventions and consumption targets of 2000 calories/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/adult equivalent per day. With limited intervention and a similar calorie intake of 1500/adult equivalent per day, 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 emphasised. 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 realised.

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 emphasises spatial and intertemporal 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 fertiliser 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.

Credit policy and intensification in mixed crop–livestock systems: A modelling 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 programmes 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' groups and specific activities, and repayment schemes. The objective of this ongoing research is to identify the appropriate credit policies for encouraging intensification. In this paper, we analyse the impact of advancing credit in kind in form of fertiliser on three groups of smallholder farmers with different levels of wealth.

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 (1986) has estimated that 50% 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 use of inorganic fertilisers. In the absence of technological response, poor smallholder 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 a higher animal population. Besides, the cultivation of pasture land 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, 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 shortages of grazing land due to expansion of crop production on grazing areas, 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 modelling results for Selale, increased fertilisation of barley, the major crop in the area, increased adoption of on-farm production of oats or 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 area, freeing land for on-farm forage production.

Substantial evidence exists supporting the productivity and profitability gains from fertiliser application and intensification. With the increased use of mineral fertiliser 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 increase 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 fertiliser 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 labour, 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 labour availability. For each group, the impact of fertiliser credit is modelled. The model selects the cropping plan, the level of fertiliser 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, fertiliser credit is used by the three groups on the two major cereals: wheat and teff. In each case, the farmer borrows sufficient quantity of fertiliser 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 are 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 fertiliser is used, according to modelling results. These results suggest that purchases of fertiliser compete unfavourably 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 fertiliser is relatively small and ranges between 115 kg for poor farmers to 240 kg for rich farmers or 207–431 Ethiopian birr (EB; US\$ 1 = EB 8 in October 1999) worth of credit. The area fertilised is also relatively small, ranging from 0.9 to 1.87 hectares (ha) with moderate rates of application. Nevertheless, the income effects were substantial. Poor farmers increase their income by 25%, while rich farmers increase their income by 57%. Moreover, application of fertiliser allowed substantial increases in the quantities of residues (straw) produced for livestock feeding, since fertilisation also enhances the growth of the above ground biomass.

The above analysis considers the effect of fertiliser 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 those of subsistence farmers.
3. Intensification of crops 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 favourable 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.

Reference

FAO (Food and Agriculture Organization of the United Nations). 1986. *Ethiopian highlands reclamation study. Final Report*. 2 volumes. FAO, Rome, Italy.

Development paths and policies for sustainable land management in Andit Tid, North Shewa: An exploration

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[Introduction](#)

[Development pathway 1980–2000](#)

[Key constraints to sustainable land management \(SLM\)](#)

[Policy options](#)

[Conclusions](#)

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:

- analyse 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 above sea level). The land is located in two altitude zones: the *dega* zone (<3200 m above sea level) and the *wurch* zone (>3200 m above sea level). Most 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 burnt¹ before planting of barley. This releases nutrients for the crop but also causes considerable losses of organic matter and soil nitrogen. One estimate suggests that 75% of the land is on steep slopes (gradients >25%).

1. Locally called *guay*

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/year distributed over two growing seasons. Droughts have not been common in the area until very recently 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 summarised in Table 1.

Table 1. *Changes in Andit Tid 1986–99.*

Variable	1986	1999
Average farm size	3.77 hectares (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

We see a considerable decline in farm size, an increase in average household size and a decrease in livestock numbers per household but an overall increase in livestock population pressure. Only 5% of the fodder was obtained from communal land while 16% was purchased, making the farm itself the major source of animal fodder. A population growth of about 3% per year has contributed to the increasing land pressure that has caused an increase in cultivated area and reduction of fallow land area. Two per cent of the land has degraded to bad land 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 Programme (SCRIP) 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, fertiliser use is risky, eucalyptus is profitable but appears to have a limited market; and
 - 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 fertilisers 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 fertiliser use; rather production risk and high fertiliser prices are limiting its 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 insufficient instrument to promote SLM.
- Credit and input supply: Care must be taken so that provision of credit and fertiliser does not become a substitute for conservation.
- Pigouvian taxes and subsidies: Taxes and subsidies may be used to internalise 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 for such policies to work. Examples:
 - Linking (subsidised) input and credit supply to conservation requirements.
 - Use food-for-work for conservation investment.
 - Labour taxation (mobilisation) 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 I: Seminar programme

Seminar on 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 Organization (EARO)
ILRI, Addis Ababa, 22–23 May 2000

Objectives

1. To familiarise 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, 22 May 2000

Session 1: Opening

Chairperson: *Prof Mitiku Haile*, President, Mekelle University

Rapporteur: *Mohammed Ahmed*

9:00 Welcome and introduction	<i>Simeon Ehui</i> , ILRI
9:15 Welcome address	<i>Peter Hazell</i> , IFPRI
9:20 Opening of seminar	<i>Ato Belay Ejigu</i> , Vice Minister of Agriculture
9:30 Project objectives, activities and organisation	<i>John Pender</i> , IFPRI
9:45 Questions/clarifications	

Session 2: Land management in the Amhara region

10:00 Land management issues in the Amhara region	<i>Lakew Desta</i> , ANRBANR,
10:30 Questions/discussion	<i>Samuel Benin</i> , ILRI
10:45 Coffee/photograph	

Session 3: Land management in the Tigray region

Chairperson: *Dr Belay Demisse*, Head, ANRBANR

Rapporteur: *Mohammed Ahmed*

11:15 Community resource management: Management of woodlots and grazing areas in Tigray	<i>Berhanu Gebremedhin</i> , ILRI
12:00 Questions/discussion	
13:00 Lunch	
14:00 Land management in the Tigray region: causes and implications	<i>John Pender</i> , IFPRI
15:00 Questions/discussion	
15:30 Coffee	

Session 3: Land management in the Tigray region (continues)

Chairperson: *Ato Wassie Berhanu*, Head, OBPED

Rapporteur: *Samuel Benin*

16:00 Small-scale irrigation systems in Tigray region: Potentials and problems	<i>Girmay Tesfaye</i> , MU
16:30 Questions/discussion	
17:00 The role of trees for sustainable land management in less-favoured lands: The case of eucalyptus in Ethiopia	<i>Pamela Jagger</i> , IFPRI
17:30 Questions/discussion	
18:00 End of first day	

Tuesday, 23 May 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	<i>Bezuayehu Tefera</i> , OADB <i>Gezahegn Ayele</i> , EARO
09:30 Questions/discussion	

Session 5: Modelling 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 bio-economic model	<i>Mohammad Jabbar</i> , ILRI
10:30 Questions/discussion	
11:00 Coffee	
11:20 Modelling the impacts of credit and land constraints	<i>Mohammed Ahmed</i> , ILRI <i>Stein Holden</i> , Agricultural University of Norway
11:50 Questions/discussion	
12:15 Options for sustainable land management in the Amhara region: A case study of Andit Tid	
12:45 Questions/discussion	

Session 6: General discussion

13:15 Review and discussion of key policy issues arising from the study 14:00 End of seminar	<i>Simeon Ehui, ILRI</i>
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