Poverty and natural resource management in the Central Highlands of Eritrea

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Chapter 1

Introduction

1.1   Background of the study

Eritrea is one of the poorest countries in Sub-Saharan Africa (SSA) with a population of 4 million of which the majority or 70 percent are engaged in rural and agricultural-based economic activities. It has one of the lowest per capita incomes in the world and high incidence of absolute poverty. Poverty is more pervasive in rural areas where about 66 percent of the poor live. The country also faces a related problem of severe food insecurity both at national and household level. Domestic production of food crops covers between 60 and 70 percent of total food needs, but this can be as low as 10 percent in poor years. The country has also limited financial capacity to cover deficits by commercial imports and thus highly depends on food aid. At the household level, the extent of food insecurity manifests itself in the level of caloric intake and nutritional composition of the typical Eritrean diet, which is below the minimum standard (GOE, 2004a).

In terms of land size, the Central Highlands (CHL) of Eritrea[1] cover about 16 percent of the total land of the country, which is 124,320 km^2 (see Figure 1.1). However, it is one of the few areas where climatic conditions allow rain-fed crop production. As a result of this and the favourable weather conditions, the Central Highlands are home to some 65 percent of the population and an important region in terms of its contribution to food production in the country (World Bank, 1994). Low and erratic rainfall, degraded soils and traditional farming practices that make little use of external inputs has led to very low levels of agricultural productivity even by SSA standards.

Land degradation, particularly soil erosion and deforestation, are the two major environmental problems in Eritrea. The problem of land degradation is particularly acute in the highlands of the country where topography is mountainous and undulating with poor vegetation cover. The relatively high

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[1] We use the terms "Central Highlands" or simply the "Highlands of Eritrea" interchangeably to refer to the study area (see Figure 1.1 and Section 5.3).

density of population and centuries of continuous cultivation have also contributed to the problem. It is estimated that 15 – 35 tons of topsoil are eroded per hectare every year. The forest cover of the country has declined from 30 percent of the total land area at the beginning of last century to only 0.8 percent at present (FAO, 1994).

The living conditions of the rural population are adversely affected by the decline in the quantity and quality of natural resources, frequent droughts and war. Agricultural productivity is decreasing with soil erosion and depletion of important nutrients. As many areas in the country are totally devoid of trees, farmers no longer get many of the services they used to get from the forests such as fuelwood, construction materials, shade etc. People have to travel longer distances and spend more time in collecting fuelwood and/or divert to lower quality sources for fuel. Dung and crop residues are used as fuel rather than as fertilizer, and this negatively affects crop yields. Livestock are being underfed due to degradation of grazing land. In general, land degradation is reducing farm income and worsening the quality of life of the rural poor.

1.2   Statement of the problem

Although the environmental problems developing countries are facing are partly due to natural factors such as drought and desertification, most of it is due to poverty-driven human activity. Conditions of high poverty are believed to induce the poor to use their resources in an unsustainable way, both due to inability to invest in natural resource management (NRM) as well as myopic survival strategies that could have detrimental effects on the natural resource base. The decline in these resources in turn deepens their poverty, making the poor both agents and victims of environmental degradation (Dasgupta and Maler, 1994). The implication of such a vicious circle relationship between poverty and environment is that policies that improve the environment will reduce poverty and reducing poverty will have a positive impact on the state of natural resources.

Agricultural intensification, which involves a more efficient use of nutrient application and improved soil and water management, is considered prerequisite to simultaneously enhance rural income and environmental sustainability in areas of high population growth (Lee *et al.,* 2000). The response of rural households to population growth and/or a decline in the availability of resources such as land, water or trees is influenced by economic and institutional factors. Absences of suitable technologies, land tenure systems that do not encourage long-term investments, absence or imperfection of markets for inputs and outputs and inappropriate policy environments often hinder the process of

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agricultural intensification in developing countries. Despite high levels of population growth, and the resulting diminishing farm size, declining yields resulting from land degradation and acute shortage of fuel wood in the Central Highlands of Eritrea, the pace of agricultural intensification is very slow.

Various policies and programs that provide a range of direct and indirect incentives to farmers to encourage them to adopt new technologies have been pursued in developing countries in the past few decades. In Eritrea as well, the Ministry of Agriculture is making considerable efforts to improve infrastructure (such as roads, dams etc.), to make modern agricultural inputs and implements available in the market at reasonable prices, to train farmers in the use of modern inputs, and to improve farmers' access to credit (GOE 1998). Considerable investments have also been devoted to combating land degradation. Between 1979 and 1992 about USD 116 million of Food for Work (FFW) assistance was allocated for hillside terracing, construction of bunds and tree planting in the country (World Bank, 1994). The government has also been mobilizing highschool students to participate in reforestation and soil conservation programs. Permanent and temporary closure programs designed to rehabilitate degraded native woodlands were initiated in various parts of the country.

Public projects such as those mentioned above and the use of incentives are often justified by divergences between private and social returns to adoption of new technologies. It is argued that some of the benefits from the adoption of some technologies may not accrue to the farmers who incur the cost. Besides, lack of information, capital and credit services in rural areas of developing countries may hinder adoption of technologies even if the technology is profitable to the farmers (Scoones and Toulmin, 1999).

While the above arguments are justified, it is possible that incentives may sometimes be used to promote technologies that are not economically or socially profitable (Enters, 1999; Pandey 2001). Thus a careful assessment of the benefits and costs of various technologies and programs needs to be made before embarking on such expensive public projects. Moreover, despite huge incentives for a long time the rates of adoption of many technologies remain very low in most developing countries. Farmers in some developing countries have even been observed reverting back to their original practices when incentives are discontinued (Shiferaw and Holden, 1998; Sanders *et al.*, 1999). In Eritrea, notwithstanding the efforts of the government, the use of modern inputs and modern agricultural practices remains very low. Although no systematic evaluation of soil and water conservation (SWC) and afforestation programs was made, there are clear indications that the achievements are modest at best. While the administrative records of the Ministry of Agriculture indicate that the

cumulative area of plantation establishments between 1979 and 1996 is about 60,000 hectares, FAO (1994) estimates show that the total area under plantation is less than 15,000 hectares. Despite the distribution of free seedlings for decades, individual tree planting in the country is not common.

1.3   Objectives of the study

Farm households' land use and land management decisions have often a simultaneous influence on rural income and the environment. These decisions, in turn, are influenced by various economic, biophysical, institutional and policy environments. Thus a thorough understanding of farm household behaviour is needed to explore if a given technology is to be accepted by farmers and to assess the effect of the technology on rural income and the environment.

The major objectives of this study are, therefore, 1) to comprehend land use and technology decisions by rural households in the Central Highlands of Eritrea, 2) to undertake a quantitative assessment of the impacts of technology change and policies (programs) on rural income and land degradation in various regions of the Central Highlands of Eritrea and 3) to analyse under which socio-economic and biophysical conditions new technologies are likely to be accepted. The specific research questions that are dealt with in this study are:

1. Which factors influence land use and technology choice decisions by rural households and how?
2. How can we assess the linkages between household decisions, rural income and indicators of sustainability?
3. What are the effects of various new technologies on rural income and land degradation in various regions of the Highlands of Eritrea?
4. How do incentives for mobilization of community labour for soil conservation and reforestation hamper private initiatives on soil conservation and tree planting activities?

1.4   Methodology of the study

To achieve the objectives and to answer the research questions we executed a thorough study of the farming systems in three subregions of the Central Highlands of Eritrea. These subregions differ in terms of population density, agricultural potential and market access. For each sub region, rural households' resource endowments, the economic, social and institutional environments that influence their livelihood strategies, as well as the major constraints they face have been explored using structured questionnaires and informal discussions

with farmers, village elders, community leaders and agricultural experts. The extents to which new technologies and modern farming practices are introduced in the various regions of the Central Highlands were also assessed. Farmers' perceptions about the risk of land degradation on their farms, as well as their perceptions about the trends of crop yields and the major reasons for such changes were also investigated.

Operations Research models are useful tools of analysis to simulate and analyse farmers' strategies under actual and potential technologies and policy conditions. Mathematical modelling can play an important role in simultaneously studying the large number of interrelated factors that influence the decisions of rural households (Schweigman, 2005). A village-level mathematical model that captures the interactions between biophysical (environmental) and socio-economic factors is developed which will be used to assess the impact of technological changes and policy incentives (Chapter six). Since consumption and production decisions of the rural households in rural areas of the Central Highlands are closely interrelated, the model considers these decisions simultaneously (see Chapter four). As biophysical and socio-economic conditions vary considerably in different parts of the highlands, different types of technologies and interventions may have different impacts on income and land degradation. As a result, farmers' willingness and ability to adopt these technologies may also differ among the different regions of the highlands of Eritrea. Thus, the mathematical model was applied to three villages representing the three subregions in the Central Highlands.

Quantitative assessment of technological changes and policy interventions on rural income and the environment requires inputs from socio-economic and biophysical sciences. The socio-economic data used in this study comes from our field studies and from studies by ministries, international organizations and regional studies. The quantification of technical data coming from other sciences (such crop yields, erosion and nutrient losses) falls outside the scope of this study. Nevertheless, as these data are key components in our model, considerable effort is made to obtain realistic parameters. The major part of these technical data is generated by making use of biophysical simulation models developed in international research institutions. The Technical Coefficient Generator (TCG) developed for the highlands of Ethiopia (Hengsdijk, 2003) is the most important source for these data. Some inputs of the the TCG are modified to reflect the biophysical conditions (e.g. altitude) of the Highlands of Eritrea. The parameters obtained using biophysical simulation models are compared with empirical evidences from agricultural research stations, and field observations and were sometimes adjusted to reflect the real situation (see Chapter seven).

1.5   Organization of the study

The thesis consists of ten chapters. Chapter one presents the background of the study, the main research questions and the objectives of the study.

Chapter two first presents a brief description of the performance of the agricultural sector in Africa and the underlying reasons for the low performance of the sector in the continent. The nature and processes of agricultural intensification, as well as the relationships between population growth, poverty and land tenure on the one hand and agricultural intensification on the other are discussed and some empirical evidences are presented.

Chapter three provides a description of the current state of the agricultural, energy and forestry sectors in Eritrea and discusses the linkages between those sectors and land degradation. It highlights the factors that contribute to the low and variable levels of crop and livestock production. It also discusses the nature and extent of land degradation in the country and the major factors that contribute to the problem.

Chapter four presents the theoretical background for the mathematical model developed in Chapter six and makes the case for the choice of the type of model. The structure of the model and the links between rural households' resource endowments, household objectives, as well as the economic and biophysical circumstances that influence their decisions are illustrated. The major components of the model are also briefly described.

Chapter five describes the study area (and study villages) and presents the methods of collecting primary data. The results of the fieldwork which include household endowments of land labour and livestock resources, farming practices and other economic activities of rural households, as well as institutional arrangements and cultural and religious factors that influence household decisions are explored. Farmers' perceptions about the impacts of some technologies on crop yields as well as the major constraints to adopt those technologies are also explored.

Chapter six presents the mathematical model in detail and Chapter seven deals with the estimation of model parameters. Particular emphasis is given in Chapter seven to the estimation of crop yields and soil losses as a function of fertilizer use and soil conservation. The Technical Coefficient Generator, which was used to estimate the above parameters, is described in detail. Empirical evidences from research stations in Eritrea were also analysed to check the validity of the data obtained from simulation models.

Chapter eight presents the results of the base model. The model was run for the three study villages separately. The results for the villages were compared to current practices to test the validity of the model. Possible reasons for divergences between simulated results and current practices were carefully discussed and implications for improvements and policy suggestions are explored. The results of the three villages were also compared with each other to give insights on the impacts of biophysical and socio-economic differences.

In Chapter nine the model is applied to assess impacts of various technologies and public projects on rural income, on land use, and on soil and nitrogen losses. This is done for each village separately. The results show the biophysical and socio-economic conditions under which each technology or intervention will be appropriate. Chapter ten presents a summary of the thesis and highlights the key findings and conclusions.

Figure 1.1   The study area