

Policy Analysis for Sustainable Land Management and Food Security in Ethiopia: A Bioeconomic Model with Market Imperfections

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Ethiopia is one of the poorest countries in the world. Most of its population of more than 65 million people lives in the highlands, where land degradation and droughts threaten food security. Highland households in less-favored areas are increasingly dependent on better market access or external assistance in order to avoid starvation.

Soil erosion in Ethiopia averages nearly 10 times the rate of soil regeneration, and the country has among the highest estimated rates of soil nutrient depletion in Sub-Saharan Africa. Such land degradation reduces average agricultural productivity. It also increases farmers' vulnerability to drought by reducing soil depth and moisture-holding capacity. The combined effects of low productivity and ecosystem degradation lock the poor in a vicious cycle of poverty and environmental degradation.

The risk of inadequate rainfall appears to have increased in recent years. Global climate changes may be responsible for the increased incidence of drought that has occurred recently in areas not affected by earlier droughts. Wars and misplaced government policies also have contributed to a vicious spiral of poverty, land degradation, and food insecurity.

There is a strong need for peace, better governance, and improved development policies to help break Ethiopia's Malthusian course and put communities onto more sustainable development paths where poverty is reduced and food security improved. Especially urgent is the need for alternative development strategies that address land degradation and food insecurity in less-favored areas, where drought risk is high or market access is poor.

THE STUDY AREA

In the Andit Tid watershed community in the eastern Amhara region of the Ethiopian highlands, both household welfare and land quality are deteriorating rapidly. Crop production is highly subsistence oriented, but the trend during the last 20 years has shifted from households being net sell-

ers of foodgrains to being net buyers. Recent droughts have even made the region dependent on food aid. Households lack off-farm income sources to protect their livelihoods against drought or other shocks. Significant interventions are urgently needed to diversify income opportunities and reverse the alarming agro-ecosystem degradation that threatens to destroy livelihoods.

Policy Analysis for Sustainable Land Management and Food Security in Ethiopia presents a bioeconomic model of this less-favored area in the Ethiopian highlands. The main reason for selecting this case study area is the unique availability of both biophysical and socioeconomic data covering a period of 15 to 20 years. The data provides a valuable opportunity to analyze the relationships between population pressure, poverty, and land degradation and to test policies for reducing vulnerability and improving sustainable management of the resource base.

ANALYTICAL FRAMEWORK

Bioeconomic models may be useful tools in policy analysis because they can reflect the biophysical as well as socioeconomic conditions essential for decisionmaking in a specific "bioeconomy." They may be used to explore the linkages between the ecology and the economy and the dynamic effects of these linkages over time. They may thus be used first to capture the essential elements leading to a specific development path in a specific bioeconomy and to make it possible to see how stable or sensitive this development path is to changes in some of the initial conditions. Second, this baseline model may serve as a starting point for "policy experiments" to assess the likely impact of alternative policy interventions. Such models have become increasingly popular in recent years in addressing issues related to agricultural land use.

The bioeconomic model used in this study analyzes the combined effects of land degradation, population growth, market imperfections, and increased risk of

drought on household production, welfare, and food security in Andit Tid. It is further used to assess the impact of increased access to credit for fertilizer, off-farm income, food-for-work (FFW) interventions, and planting of eucalyptus trees as alternative strategies for local development.

REDUCING POVERTY AND LAND DEGRADATION

The model predicts that provision and adoption of credit for fertilizer, although risky, would lead to increased grain production and improved household welfare and food security. However, provision of credit for fertilizer has a negative effect on incentives to conserve land, resulting in higher erosion rates when such unlinked credit is provided. Linking a conservation requirement to the provision of fertilizer credit can mitigate this negative outcome. Overall, however, even the combination of conservation structures and high levels of fertilizer use cannot sustain crop yields as erosion cannot be eliminated fully and soils in the area are shallow.

Better access to off-farm income can improve household income and reduce vulnerability to drought. It may, however, also reduce incentives for food production and land conservation. The effects of FFW on food production and farmland conservation can be very different depending on how and for what activities FFW is used, on the characteristics of the labor market, and on the impact of conservation technologies on short-term agricultural yields. FFW programs may undermine food production and incentives to conserve land unless FFW is linked to land conservation or better land management. The participation of local communities and good knowledge of farming systems, distribu-

tion of resources, local markets, and prices, and how different interventions affect production, conservation, and welfare is needed to avoid program design failures. FFW may be used to enhance food security and land conservation provided that programs are compatible with local priorities.

Planting trees, especially eucalyptus, on agriculturally marginal land may be a promising option for Ethiopian farm households. When other employment opportunities are limited, planting eucalyptus on land unsuitable for crop production may substantially increase household income if market outlets for trees can be identified. Our analysis suggests that tree planting on marginal lands will not have severe negative effects on food production or land conservation.

The combination of tree planting and FFW for conservation appears to produce superior outcomes. A policy combining promotion of tree planting and conservation of cropland may achieve win-win benefits in terms of increased household incomes as well as more sustainable land use. Careful program design and implementation is required to maximize such benefits.

Finding solutions to the downward spiral of land degradation and poverty requires identifying effective entry points for farmers, governments, and civil society organizations, and understanding the potential impacts and tradeoffs that are likely to arise from alternative interventions. Our analysis of the Andit Tid watershed community should be useful to policymakers and others seeking to reduce poverty and improve land management in Ethiopia and other countries where such problems are severe. Beyond this, the bioeconomic modeling approach used in this study can be usefully adapted and applied in many other settings.

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