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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 m^3 compared with 1.2 m^3 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.