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Effect of prior land use on the recolonization of native woody species under plantation forests in the highlands of Ethiopia

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Abstract

Effect of prior land use on the recolonization of native woody species in plantation forests was investigated by assessing naturally regenerating flora (NRF) and soil seed banks (SSB) in plantation forests established on abandoned farmland and cleared natural forest sites in southern highlands of Ethiopia. *Eucalyptus saligna* and *Cupressus lusitanica*, two of the most widely planted tree species in the highlands of Ethiopia, were considered in the plantation treatments. About 66 plant species were recorded in the NRF and 55 plant species germinated from the soil samples collected for SSB analysis. Seedlings from the SSB were dominantly herbs, which accounted for 75% of the identified species germinated from the SSB, and native woody species accounted only for 10%. On the contrary, in the NRF native woody species were slightly more dominant (49%) than the herbs (45%). There was high species similarity between the NRF beneath the plantations and the standing vegetation in the adjacent natural forest. On the contrary there was very low similarity between the seedlings emerged from the SSB and the standing vegetation in the adjacent natural forest. Effect of prior land use was apparently stronger on the species composition of the SSB than the species richness of NRF under the plantations. The results also showed that overstory plantation species had stronger influence on the species richness of NRF rather than the pre-plantation land use history. As the SSB of the plantation sites lacked viable seed reserves for most of the naturally regenerating woody plants recorded underneath the plantations of both sites, it was assumed that seed dispersal from the adjacent natural forest has played major role in the recolonization process. From these results it could be shown that establishment of plantation forests either on abandoned farmland or directly on

Abbreviations: ANOVA, analysis of variance; CLNF, *Cupressus lusitanica* established on cleared natural forest site; CLFL, *C. lusitanica* established on ex-farmland; ESFL, *Eucalyptus saligna* established on ex-farmland; ESNF, *E. saligna* established on cleared natural forest site; FAO, Food and Agricultural Organization of the United Nations; FL, farmland; JSC, Jaccard's Similarity Coefficient; NF, natural forest; NRF, naturally regenerating flora; PCA, principal component analysis; PFL, plantations established on ex-farmland; PNF, plantations established on cleared natural forest site; SSB, soil seed banks; SFIE, Shashamane Forest Industry Enterprise

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degraded natural forest sites can create comparable enabling environment for the recovery of the native forest flora, even if SSB are devoid of viable seeds of woody species, provided that there is a natural forest in the vicinity to donate seeds.
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1. Introduction

Fast growing tree plantations, including the controversial eucalypt species, on degraded tropical sites have been shown to expedite native woody species recolonization by acting as nurse crops (e.g. Lugo et al., 1993; Lugo, 1997; Parrotta, 1992, 1995; Senbeta and Teketay, 2001; Senbeta et al., 2002; Yirdaw and Luukkanen, 2003; Lemenih et al., 2004). The plantations accelerate native woody species recolonization by influencing understory microclimate and soil fertility, suppressing competitive grasses and by attracting seed dispersers through the provision of habitat (Parrotta et al., 1997; Wunderle, 1997). In fact, there are different sources of propagules to initiate natural regeneration underneath the plantations, namely soil seed bank, seed rain and coppices from damaged trees (Brokaw, 1985; Garwood, 1989; Teketay, 1996). However, pre-plantation land uses are likely to affect several aspects of site conditions such as soil seed banks and soil fertility that may retard native forest succession underneath plantation forests (Nepstad et al., 1996; Duncan and Chapman, 1999). Persistent effects of prior land uses have been reported in plant community assembly in temperate (Foster, 1992; Motzkin et al., 1996; Keersmaeker et al., 2004) and tropical (Foster et al., 1999) forests. Furthermore, the strength of degraded site characteristics to slow forest succession is strongly related to the nature, duration and intensity of former land use (Brown and Lugo, 1994; Teketay, 1998; Honnay et al., 1999; Davy, 2002). For instance, conversion of natural forest to plantation forestry allows good persistence of native seeds, while repeated cultivation may lead to the destruction of the indigenous seed banks (Davy, 2002).

Recently, several studies have assessed native woody recolonization under plantation forests in the highlands of Ethiopia (e.g. Yirdaw, 2001; Senbeta and Teketay, 2001; Senbeta et al., 2002; Yirdaw and Luukkanen, 2003; Lemenih et al., 2004). However, there has been no study that assessed the impact of prior land use on naturally regenerating flora (NRF) beneath plantation forests as well as on the floristic richness of soil seed banks (SSB) in the highlands of Ethiopia. The objectives of this study were to: (1) assess the density and floristic richness of NRF beneath plantation stands established on abandoned farmland (PFL) and plantations established on cleared natural forest sites (PNF); (2) investigate the effect of pre-plantation land use on the recolonization of native forest flora in plantation forests; (3) investigate the effect of prior land use on the richness and role of SSB in contributing to the NRF underneath plantation stands.

2. Materials and methods

2.1. Study area

The study was undertaken at Lepis, near the Gambo district of the Shashamane Forest Industry Enterprise (SFIE), situated approximately at 7°20′N and 38°45′E. The study sites lie between the altitudes of 2100 and 2200 m above sea level. There are two rain seasons in the area: the short rainy season occurs between March and June and the major rainy season is between July and October. Mean annual temperature ranges from 22.2 °C (hottest month) to 5.6 °C (coldest month) (Teshome and Petty, 2000), and with rare occurrence of frost. The soil parent materials consist of volcanic lavas, ashes and pumices from quaternary volcanic activities in the Rift Valley (Abebe, 1998). The soils of the area are classified as Mollic Andosol (Lemenih, 2004).

The natural forest around Lepis belongs to a tropical dry Afromontane forest (Lundgren, 1971). *Afrocarpus falcatus* is the dominant canopy tree in the natural forest, with different mixtures of *Ekebergia capensis*, *Celtis africana*, *Croton macrostachyus* and *Prunus africana* along the altitudinal gradient. However, pressure from increasing population and unplanned utilization of the forest has decreased the area of the natural forest and its productivity (Seifu,

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