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Creating woodland islets to reconcile ecological restoration, conservation, and agricultural land use

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Restoration initiatives seek to address widespread deforestation and forest degradation, but face substantial problems. "Passive restoration", whereby abandoned agricultural land undergoes secondary succession, is often slow, owing to biotic and abiotic limitations. "Active restoration", chiefly accomplished by planting trees, can be very expensive if large areas are to be restored. We suggest "woodland islets" as an alternative way to achieve ecological restoration in extensive agricultural landscapes, particularly in low-productivity environments. This approach involves the planting of many small, dense blocks of native trees to enhance biodiversity and provide a range of ecosystem services. If the surrounding land is abandoned, the islets act as sources of woodland species and seed, which can accelerate woodland development. Alternatively, if the surrounding area is used for cultivation or pasture, the islets will increase the conservation value of the land and offer the potential for income generation. Here, we review existing approaches to woodland restoration and evaluate the relative strengths and weaknesses of the woodland islets approach.

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In the debate over how to balance conservation and exploitation of ecosystems, no human activity is as controversial as agriculture (Green *et al.* 2005; Matson and Vitousek 2006). From the boreal regions to the tropics, widespread deforestation, often for the purpose of conversion to agricultural land, has resulted in major environmental problems, compromising ecosystem services. These problems include loss of biodiversity, soil erosion, mobilization of stored carbon and soil nutrients, depletion of usable water resources due to run-off, contamination of waterways, and lowering of water tables (Schröeter *et al.* 2005). Today, croplands and pastures have become the largest single terrestrial biome, accounting for ~ 40% of the planet's land surface (Foley *et al.* 2005). This area is likely to expand in the immediate future, resulting in continued deforestation, which has occurred at an estimated global rate of 130 000 km^2 per year for the past 5 years (FAO 2006).

In a nutshell:

- Agriculture is often in conflict with other environmental services that natural or cultural landscapes provide to humans
- This is the "agriculture and conservation paradox", and can be addressed by ecological restoration
- Natural regeneration of woodland restores more land at lower cost than active planting of forests, but is often slow because seed dispersal is limited and adverse environmental conditions constrain tree establishment
- The "woodland islets" approach uses local-scale management interventions to support natural regeneration over larger areas
- This could reduce costs compared to extensive reforestation, increase conservation value of agricultural land, enhance provision of ecosystem services, increase income, and improve social and educational resources

Traditional agriculture typically restricts natural vegetation to valleys and saline, infertile areas, and on steep hillsides, rocky outcrops, shallow soils, property boundaries, and track edges. More recently, farming practices in many areas have intensified, and increasing amounts of water, fuel, fertilizers, pesticides, and herbicides are used worldwide to increase food and fiber production (Figure 1). Intensification of land use has brought remnant areas of natural vegetation into mainstream agriculture and many such areas have been lost or severely degraded as a result. Globally, degradation of land as a consequence of agricultural activities is estimated at about 12 400 000 km^2, and ranges between 10–20% in the dryland areas of the planet (Lepers *et al.* 2005; see also LADA 2007).

Patterns of land-use change are complex. Agricultural intensification and deforestation to create farmland can occur alongside extensive farmland abandonment, which, in turn, can lead to succession back to forest (Rey Benayas 2005). Agricultural abandonment is a global phenomenon and is usually a result of rural–urban migra-

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