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From Forest Nursery Notes, Winter 2011

185. © Survival and growth of tree species under two direct seedling planting systems. Bruel, B. O., Marques, M. C. M., and Britez, R. M. Restoration Ecology 18(4):414-417. 2010.

SHORT COMMUNICATION

Survival and Growth of Tree Species under Two Direct Seedling Planting Systems

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LAW (TITLE 17, U.S. CODE)**Abstract**

Direct tree planting restoration systems are frequently used for recovering degraded tropical landscapes. Although manual planting tends to be more viable economically and logistically over small areas, in large restorations the use of agricultural equipment that optimizes effort is preferable. The aim of this study was to investigate the efficiency of the two native tree species planting systems—manual and mechanized—used in the restoration of Atlantic Forest landscapes that have been converted to pasture. In recently abandoned grazing areas with abundant cover of the exotic grass *Brachiaria humidicola*, 393 seedlings of 6 species were planted in two treatments: a mechanized planting system (soil prepared with a rotary tiller attached to a tractor; seedlings in polypropylene tubes) and a manual planting system (holes dug with a manual

excavator; seedlings wrapped in polyethylene bags). After 12 months, survival (manual: 85%; mechanized: 71%) and growth rates (RGR_{height} : manual = 0.88 ± 0.06 and mechanized = 0.98 ± 0.06 cm/cm; RGR_{diameter} : manual = 0.77 ± 0.05 and mechanized = 0.86 ± 0.05 cm/cm) were high in both treatments, but no differences were found between them. Both planting systems proved efficient for planting native tree seedlings in pastures. The excellent results demonstrated in this study by the mechanized planting system are important because this cheap and readily available technique provides a good, but less frequently used, alternative to the manual planting system.

Key words: abandoned pasture, Atlantic Rainforest, *Brachiaria*, manual planting, mechanized planting, tropical forest.

Introduction

Forest restoration is an essential instrument for recovering tropical degraded areas and rescuing at least a minimum of the form and function inherent in pristine landscapes (Hobbs & Harris 2001; Kageyama et al. 2003; Lamb et al. 2005). Especially in tropical landscapes dominated by abandoned pastures in which exotic grasses inhibit natural regeneration or seed sources are lacking, direct tree planting plays an important role in accelerating forest recovery (Aide et al. 2000; Florentine & Westbrooke 2004; Holl 1999; Zimmerman et al. 2000).

Although potentially efficient, direct tree planting restoration systems have some logistical and economic complications, which ought to be considered before their use in degraded areas. Planting trees requires investments in nursery seedling production, soil preparation, and seedling planting (Kageyama et al. 2003). Most restoration programs involving native species employ human labor (Rodrigues et al. 2009),

which tends to be more viable economically and logistically over small areas. Heavy machinery is rarely used to restore native tropical forests (Ferretti & Britez 2006), and comparisons of the relative costs and benefits of manual and mechanized systems for restoring tropical forests have never been conducted.

In this study we evaluated one restoration program in the Atlantic Rainforest of Brazil. Previous experiments in the region have reported the use of the well-known manual plantation system (Kageyama et al. 2003; Rodrigues et al. 2009; Souza & Batista 2004). In Southern Brazil a pioneering initiative has incorporated a mechanized planting system to restore large areas (Ferretti & Britez 2006). This article compares seedling growth and survival to evaluate the efficiency of the two native tree species planting systems—manual and mechanized—used in the restoration of pastures to tropical forests.

Study Site

The study was carried out at the *Rio Cachoeira* Reserve ($25^{\circ}19'15''\text{S}$ and $45^{\circ}42'24''\text{W}$) in state of Paraná, Brazil. The reserve (8,500 ha) belongs to the non-governmental organization *Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental* (SPVS) and is composed of successional forests and abandoned pastures once used for buffalo ranching in which

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