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Life cycle assessment of the production and use of polypropylene tree shelters

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ABSTRACT

A detailed Life Cycle Assessment (LCA) has been conducted for the manufacture, use and disposal of polypropylene tree shelters, which are used to protect young seedlings in the first few years of growth. The LCA was conducted using Simapro software, the Ecoinvent database and ReCiPe assessment methodology. Detailed information on materials, manufacturing, packaging and distribution of shelters was obtained from Tubex Ltd. in South Wales, UK. Various scenarios based on different forest establishment methods, with or without tree shelters were derived and analysed using data from published literature and independent sources. The scenarios included commercial forestry in northern temperate conditions, amenity forest establishment in temperate conditions, and forest establishment in semi-arid conditions. For commercial forestry, a reduction in required seedling production and planting as well as additional time-averaged wood production led to significant benefits with tree shelters, both compared to unprotected and fenced cases. For the amenity forest scenarios, tree shelter use had a net environmental impact, while for semi-arid forestry, the benefits of reduction in water use outweighed shelter production impacts. The current practice of in-situ degradation was compared to collection and disposal and it was found that in-situ degradation was slightly preferable in terms of overall environmental impact. Use of biopolymer-based shelters would improve the environmental performance slightly.

1. Introduction

Tree shelters are translucent thermoplastic tubes placed around young tree seedlings for the first few years of growth and they have become quite widely used since their introduction in the early 1980's (Tuley, 1985). The potential benefits of their use to protect young trees include the reduction of damage by browsing animals (Bendfeldt et al., 2001; Gravatt and Mauney, 2005; Runde et al., 2008; Sweeney and Czapka, 2004; Trout and Brunt, 2008), the creation of a beneficial local microclimate within the shelter (Bergez and Dupraz, 2009; Chaar et al., 2008), protection against herbicides, protection from wind damage, protection from weed competition (Lof et al., 2004; Trout and Brunt, 2008; Ward and Mervosh, 2008) and reduction in water loss (Chaar et al., 2008; Gravatt and Mauney, 2005; Oliet et al., 2005). There has been considerable study into the use of tree shelters in the last 30 years, and this has led to an improved understanding of how tree shelters should be used. There are some situations where shelters give little benefit, but in cases where browsing damage or water stress is significant, they give definite benefits to the successful establishment of trees.

Despite their economic value, the overall environmental impacts of tree shelters have yet to be assessed, especially with the current practice of allowing shelters to degrade in-situ rather than requiring them to be collected. The purpose of this study is to conduct a life cycle assessment (LCA) of the manufacture, distribution, use and degradation of polypropylene tree shelters, using a variety of realistic use scenarios. An assessment of the possible benefits of collection of tree shelters after use and the use of biopolymer-based shelters is also included in this study.

2. LCA methodology

2.1. Goal

The goal was defined as "to study the environmental impacts of various forest establishment practices, with an especial focus on tree shelter use". A deliberate decision was made to focus purely on the methods by which a certain density of mature trees can be established in three different cases; commercial forestry in northern temperate conditions, amenity forest establishment in temperate conditions, and forest establishment in semi-arid conditions. The environmental benefits of forest establishment in its own right can be very large, with significant uncertainties in respect of carbon sequestration over long timescales and so

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