Eucalyptus Plantations: Review on Management, Modelling, Environmental Effects and Landscape

Blas Mola

School of Forest Sciences, University of Eastern Finland, PO Box 111, FI-80101 Joensuu, Finland

August 18, 2025

Review of Research, Biomass Production Research Group

Abstract

This article presents a short review and synthesis of recent research on *Eucalyptus* plantations carried out by the Biomass Production Research Group. Over the last years, our studies have explored silvicultural management alternatives, growth and yield modelling, environmental assessments, and landscape implications of *Eucalyptus* cultivation. The results emphasise the potential of innovative management strategies such as thinning, pruning, and coppice-with-standards systems to enhance both productivity and wood quality. In parallel, modelling approaches, ranging from height–diameter equations to climate-sensitive growth and yield simulators, provide valuable tools for decision-making under changing climatic and market conditions. Environmental perspectives, including life cycle assessment studies, underline the importance of optimising management practices to mitigate impacts, while landscape-level analyses highlight the dual role of plantations in either homogenising or diversifying land use. Together, these studies provide an integrated overview of the opportunities and challenges of *Eucalyptus* as a multipurpose crop, while ongoing research continues to expand this knowledge base in response to global bioeconomy demands.

Keywords: Eucalyptus, silviculture, biomass, growth models, life cycle assessment, land use, bioeconomy

Introduction

Eucalyptus species represent one of the most important plantation resources worldwide, with over 20 million hectares established across tropical, subtropical, and Mediterranean regions (Ferraz Filho et al., 2014). Their rapid growth, adaptability, and multipurpose use make them central to modern plantation forestry. Eucalypt stands supply raw material for pulp and paper, energy, construction timber, and increasingly, high-value solid wood products (Ferraz Filho et al., 2018a). In Brazil, for example, eucalypts cover approximately 7.5 million hectares, while in Chile, *Eucalyptus globulus* constitutes a major resource for both pulp and bioenergy industries (Morales et al., 2015). Plantation management regimes vary widely, from short-rotation coppices for bioenergy to longer rotations for sawtimber, reflecting both market demands and site conditions.

Management alternatives

Management research has explored alternative silvicultural systems aimed at diversifying products and improving wood quality. The coppice-with-standards system (CWS) allows simultaneous production of small-diameter biomass and high-quality timber, leveraging eucalypt sprouting capacity and suitability for multiple products (Ferraz Filho et al., 2014). Complementary studies on thinning and spacing regimes have shown that early thinning and reduced stand densities promote diameter growth and log quality, providing valuable options for solid wood production (Ferraz Filho et al., 2018a). Similarly, pruning experiments demonstrated that pruning up to 70% of crown height in young stands can increase the production of clear wood without major growth losses, whereas excessively intense interventions reduce productivity (Ferraz Filho et al., 2016). Together, these studies illustrate a range of management strategies that enable plantation owners to adapt to changing market opportunities while maintaining productivity.

Growth and yield modelling

Growth and yield modelling has been essential to support decision-making in eucalyptus plantations. Height–diameter models based on mixed-effects approaches have been developed for Brazilian plantations, covering diverse thinning regimes, planting densities, and clonal materials, enabling accurate and cost-effective forest inventories (Ferraz Filho et al., 2018b). At broader scales, climate-sensitive models allow scenario simulations that integrate management alternatives with climatic variability, providing robust

projections for national and regional forest resources (Trasobares et al., 2021). These modelling frameworks are increasingly critical for planning under climate change, supporting sustainable biomass supply, and integrating ecosystem service considerations into forest policy.

Environmental and landscape perspectives

Beyond productivity, the environmental and landscape dimensions of eucalyptus plantations have been widely studied. A cradle-to-gate life cycle assessment (LCA) of *E. globulus* in Chile showed that harvesting operations contribute disproportionately to environmental impacts, highlighting the need to optimise fertiliser use and fuel consumption (Morales et al., 2015). At the landscape scale, plantations may bring both positive and negative effects. Pineda-Zapata and Mola-Yudego (2025) found that depending on their spatial configuration, biomass plantations such as eucalypts can either homogenise landscapes and reduce biodiversity or, conversely, enhance land use diversity, connectivity, and multifunctionality. Thus, their role in European and global landscapes remains context-dependent, shaped by spatial deployment, management practices, and integration with other land uses.

References

Ferraz Filho, A. C., Mola-Yudego, B., González-Olabarria, J. R., and Scolforo, J. R. S. (2016). Pruning effect in eucalyptus grandis × eucalyptus urophylla clone growth. *Scientia Forestalis*, 44(111):729–738.

Ferraz Filho, A. C., Mola-Yudego, B., González-Olabarria, J. R., and Scolforo, J. R. S. (2018a). Thinning regimes and initial spacing for eucalyptus plantations in brazil. *Anais da Academia Brasileira de Ciências*, 90(1):e20150453.

Ferraz Filho, A. C., Mola-Yudego, B., Ribeiro, A., Scolforo, J. R. S., Loos, R. A., and Scolforo, H. F. (2018b). Height–diameter models for eucalyptus sp. plantations in brazil. *CERNE*, 24(1):e2466.

Ferraz Filho, A. C., Scolforo, J. R. S., and Mola-Yudego, B. (2014). The coppice-with-standards silvicultural system as applied to eucalyptus plantations – a review. *Journal of Forestry Research*, 25(2):237–248.

Morales, M., Aroca, G., Rubilar, R., Acuña, E., Mola-Yudego, B., and González-García, S. (2015). Cradle-to-gate life cycle assessment of eucalyptus globulus short rotation plantations in chile. *Journal of Cleaner Production*, 99:49–59.

Pineda-Zapata, S. and Mola-Yudego, B. (2025). European biomass production systems: Characterization and potential contribution to land use diversity. *GCB Bioenergy*, 17(7):e70057.

Trasobares, A., Mola-Yudego, B., Aquilué, N., González-Olabarria, J. R., Garcia-Gonzalo, J., García-Valdés, R., and De Cáceres, M. (2021). Nationwide climate-sensitive models for stand dynamics and forest scenario simulation. *Forest Ecology and Management*, 505:119909.