

Abstract

Productivity and Life Cycle Assessment (LCA) of Tree Felling by Chainsaw in Thinning of Calabrian Pine Stands [†]

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Abstract: Forest mechanisation plays an important role in increasing labour productivity and reducing production costs. Chainsaws are the most commonly used tool used for tree felling and can have both positive and negative environmental impacts on the forest ecosystem. Impacts that should be analysed considering all implemented inputs and outputs related to the involved technology. This work aims at evaluating the operational and environmental performance of a medium-sized chainsaw during a second thinning carried out on Calabrian Pine high forests. The trees, located at an altitude of 1100 m a.s.l, had an average diameter at the breast height of 30.6 cm and a height of 18 m for a density of 950 trees ha⁻¹. The terrain roughness presents obstacles on less than 1/3 of the surface while the slope was between I and II classes (0–40%). A work time study on the felling operation was conducted considering a full-tree system. Thirty operational cycles were registered: observed time was separated into working time, which included main and complementary working times, calculated as average gross productivity, inclusive of all delays up to the maximum event duration of 15 min. The life cycle assessment (LCA) approach was adopted for environmental performance. As a functional unit, 1 m³ of round wood was chosen. The inventory data, relating to the background processes, were collected from Agribalyse 3.0.1., while data from the foreground, such as materials and fuel consumption, were directly collected. Environmental impact data were processed using OpenLCA software and the ReCiPe 2016 method at the midpoint level. Team productivity was equal to 10.30 trees h⁻¹, corresponding to a volume of timber of 11.2 m³ h⁻¹. Considering a working day of 8 h, productivity was equal to 41 trees d⁻¹ worker⁻¹ for a volume of timber of 44.8 m³ d⁻¹ worker⁻¹. The performed LCA showed that emissions related to the stage of use represented a major hotspot in “Global warming” (2.169 kg CO₂ eq.), “Ozone Formation–Human Health” (0.038 kg NO_x eq.), “Fine particulate matter formation” (0.001774 kg PM 2.5 eq.) and “Terrestrial ecotoxicity” categories (4.234 kg 1,4-DCB). In conclusion, the analysed site showed a suitable level of internal organization, but more regular management of the chainsaw is required. The environmental impact is affected by the energy systems in the use phase but is needed to deepen the knowledge of all aspects involved from upstream processes for certain materials to manufacture components.

Keywords: forest mechanisation; work productivity; life cycle assessment (LCA); environmental impact



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