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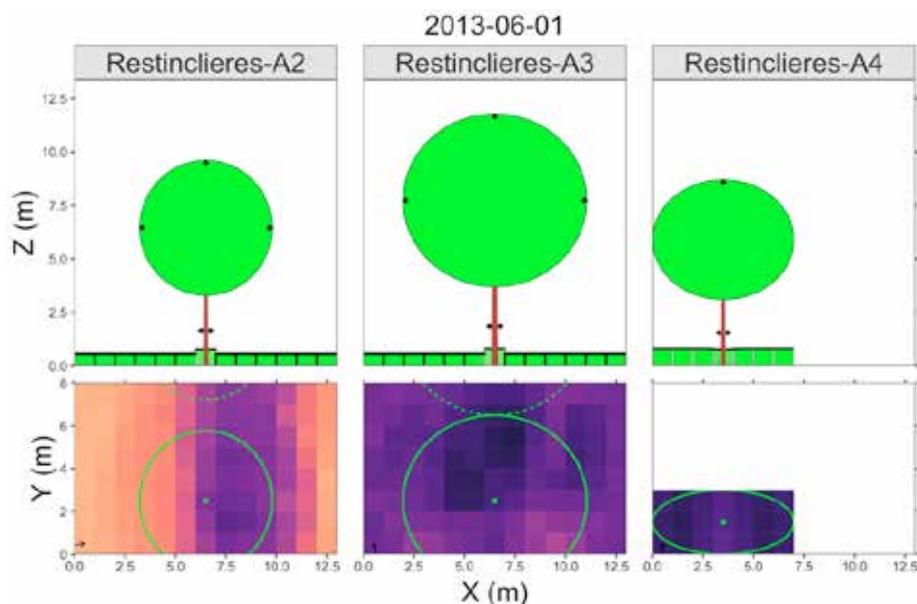
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### Theory and description of the 3D Hi-sAFe agroforestry model

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Hi-sAFe is a mechanistic, biophysical model designed to explore the interactions within agroforestry systems that mix trees with crops. Hi-sAFe has been under development since 2002 via the Silvoarable Agroforestry for Europe (SAFE) project (Dupraz et al. 2005) and was partially described by Talbot (2011). The model couples the pre-existing STICS crop model (Brisson et al. 1998) to a new tree model. Trees and crops compete in 3D for light, water and nitrogen at a daily time step. Modelled system geometry can be custom built using a grid of square cells and flexible boundary conditions, permitting the simulation of isolated trees, tree lines, stand edges, and a wide range of agroforestry patterns. An opportunistic tree growth module (Mulia et al. 2010) accounts for the impact of resource availability on tree root architecture. Monoculture crop and tree systems can also be simulated, enabling calculation of the land equivalent ratio of agroforestry systems. Hi-sAFe is a novel tool for elucidating daily interactions for light, water, and nitrogen in agroforestry systems. Its 3D and spatially explicit form is key for accurately representing many competition and facilitation processes. Hi-sAFe is available online free of charge. A suite of tools for building, running, and analyzing Hi-sAFe simulations is also available via the *hisafer* R package.



A snapshot of one day of three Hi-sAFe simulations. The top row illustrates a horizontal projection of the modelled scene. The bottom row shows a top-down view of the scene, with cell color proportional to shade by the tree on the crop (darker colors indicate more shade).

**Keywords:** Competition; Facilitation; Roots; light; water; nitrogen.

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