Proceedings of the 7th International Conference on Functional-Structural Plant Models, Saariselkä, Finland, 9 - 14 June 2013. Eds. Risto Sievänen, Eero Nikinmaa, Christophe Godin, Anna Lintunen & Pekka Nygren. http://www.metla.fi/fspm2013/proceedings. ISBN 978-951-651-408-9.

# "Virtual grassland": an OpenAlea package to deal with herbaceous plant architecture and grassland community dynamics

**Gaëtan Louarn*, Abraham Escobar-Guttierrez, Didier Combes**
*INRA, UR4 P3F, BP6, F-86600 Lusignan, France*
* gaetan.louarn@lusignan.inra.fr

**Highlights:** The "Virtual grassland" OpenAlea package was developed to provide herbaceous plant models and coupling methods with soil and light transfer modules. It aims at simulating the effects of competition and facilitation interactions at the population and community levels in grasslands.

**Keywords:** Architecture, grass, legume, community, dynamics

Grasslands are the major source of forages worldwide. They are exploited via grazing and mowing and can be natural or cultivated. Their agricultural use-value depends on the structure of their canopy and on their botanic composition (most are indeed multi-specific). Both determine the quantity and the quality of the biomass harvested by grazing or mowing. In temperate grasslands, perennial grasses and forage legumes dominate the floristic composition of grasslands and are generally intended to be grown in mixtures because of their agronomic (feeding value) and ecological (resource capture and use) complementarities. An appropriate species balance is however difficult to maintain in such non-equilibrium communities. The proportion of forage legumes fluctuates both from year-to-year and within a single growth period as a result of species interactions and management. In spite of its agronomic significance, most grassland models developed so far ignore plant-plant interactions and the community dynamics of grasslands. Efforts have been done mainly on white clover based mixtures for which a gain of understanding of coexistence conditions was achieved thanks to individual-based models. White clover has however rather atypical colonisation strategy and persistence habit among forage legumes and these predictions may present a limited interest for other grass-legume combinations. To deal with this question, the "Virtual grassland" package was developed under the OpenAlea platform (Pradal et al. 2008) to simulate the architecture of various grass and legume species and predict the effects of competition / facilitation interactions at the population and community levels.

The "Virtual grassland" package provides i) two generic plant models accounting respectively for grass (L-grass) and legume (L-egume) morphogenesis above- and below-ground, and considering responses to defoliation (Verdenal et al. 2008), ii) coupling methods (in the form of OpenAlea nodes) between the MTG central data structure for plant architecture and environmental models above- (light) and belowground (water and soil N) available through the platform and finally iii) dataflows enabling to scale up from plant to community and ecosystem (soil-plants-atmosphere) levels by combining the different plant and environmental models together, and providing a graphical interface to manage model input parameters and visualise simulation results. The two plant models are based on the l-system formalism (L-py software) and aim at accounting for intra- and inter- specific variations in morphogenesis, dry matter production and C/N composition. In the legume functional group, different growth habit in terms of shoot growth (erect/prostrate), branching, coordination of organ growth and ability to develop adventitious roots/shoots enable to distinguish between colonisation strategies ranging from herbs perennating by formation of a single taproot (such as alfalfa or red clover) to clonal patches resulting from rhizome spreading (creeping lucerne) or rooted shoots at the soil surface (white clover). Similarly, in grasses, differences in the self-regulation of leaf growth and tiller development enable to account for growth habit ranging from long-leaf forage species/cultivars to short-leaf turfs. Leaf gas-exchange is simulated using the Farqhar model. A simple soil model adapted from the STICS soil module is currently tested for water and nitrogen acquisition. The coupled soil-plant-atmosphere model is currently being assessed both for the behaviour of isolated plants, and the dynamic of plant populations into binary species mixtures.

## LITERATURE CITED

**Pradal C, Dufour-Kowalski S, Boudon F, Fournier C, Godin C. 2008.** OpenAlea: a visual programming and component-based software platform for plant modelling. *Functional Plant Biology* **35**(10): 751-760.

**Verdenal A, Combes D, Escobar-Gutiérrez AJ. 2008.** A study of ryegrass architecture as a self-regulated system, using functional–structural plant modelling. *Functional Plant Biology* **35**: 911–924.