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# Adapting FLORSYS for climate change: implementing plant-plant competition for water in a 3D mechanistic model for predicting future crop/weed interactions and their consequences in arable cropping systems

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Implementing plant-plant competition for water in a 3D mechanistic model for predicting future crop/weed interactions and their consequences in arable cropping systems

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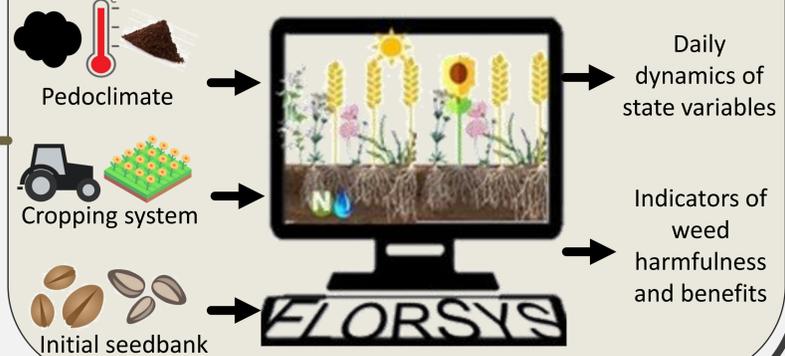
**Context:** How to design climate-resilient arable cropping systems to sustainably manage weeds?

**Weeds**  
Pest causing the most yield losses in arable crops (Oerke, 2006)



Modelling crop/weed interactions

**FLORSYS:** Simulates the effects of cropping systems on the multi-annual dynamics of crops, weeds and their consequences (Colbach et al., 2021)



Operational to design multi-performant and low-input systems

Partially operational to design climate-resilient systems



Workshops with farmers and crop advisors (Queyrel et al., 2023)



Does not include all relevant mechanisms

Work in progress

## Objective

Build a water competition submodel for FLORSYS



The submodel is expected to:

- Extend FLORSYS' validity domain to climate change
- Represent water uptake, water competition and consequences on growth

The submodel will be:

- Connected to other submodels (phenology, nitrogen, light)
- Based on either existing formalisms, or new experimental formalisms
- Generic, with few parameters

## Some formalisms derived from existing models

(Ritchie, 1998; Brisson et al., 2008; Louarn et Faverjon, 2018)

- Water availability (STICS soil submodel) and demand (Virtual grassland)
- Water stress → photosynthesis (APSIM / DSSAT)

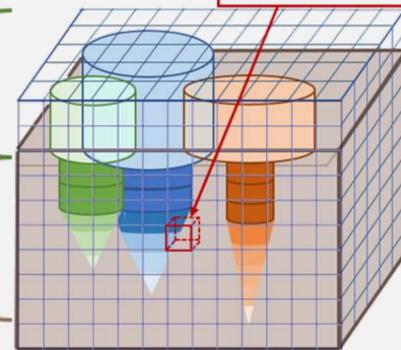
- Only 7 species-specific parameters → Plant demand and maximum root uptake  
 → Water stress → morphology and photosynthesis

## Results

FLORSYS base unit: the voxel

A two-scale modelling

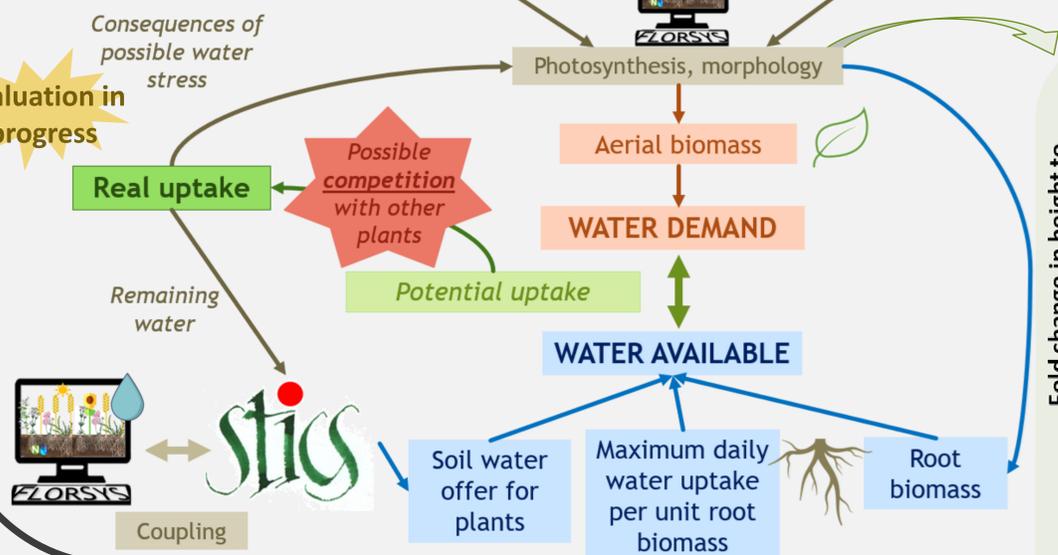
Aboveground part of plants: cylinders  
 Belowground part of plants: inverted cone topped by a cylinder



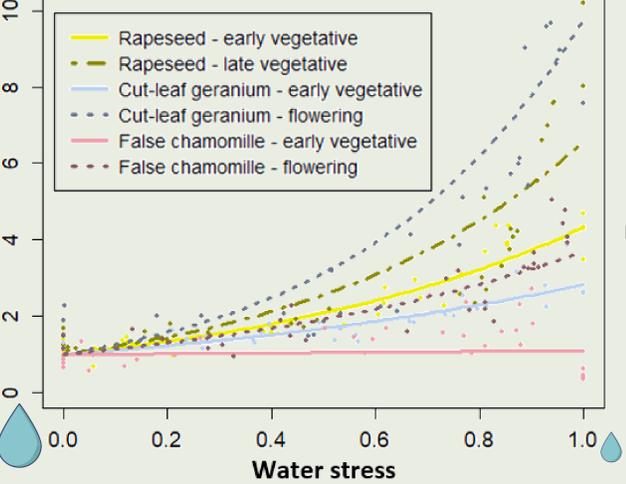
Water uptake is modelled at the plant level and depends on plant demand and soil water available for the plant

Competition occurs at the soil voxel level, when the demand of all plants with roots in the voxel exceeds water availability

Evaluation in progress



Fold change in height to aboveground biomass ratio (cm/g) compared with unstressed plants



Example of results from experiments to model the interspecies diversity in morphological responses to water stress

The parameters of the response curves reflect species- and stage-specificities

WCRP World Climate Research Programme CMIP6

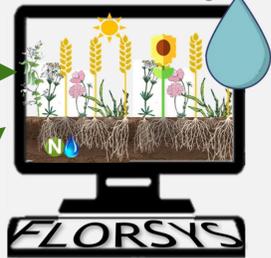
Predicted global climate (Xu et al., 2021)



Downscaling

High resolution daily climate over France

Current and virtual arable cropping systems



Projected weed flora in arable cropping systems

Traits of climate-selected weeds

Decision rules to design innovative systems

**Conclusion:** FLORSYS becomes the first weed model to simulate competition for light, water and nitrogen. Fed with high resolution climate datasets, FLORSYS will help co-designing sustainable and climate-resilient cropping systems, for long-term weed management

## Literature:

Brisson N., 2008. Quae Editions. ISBN: 978-2-7592-0169-3; Colbach N. et al., 2021. Field Crops Res., 261, 108006. DOI: 10.1016/j.fcr.2020.108006; Louarn G. et Faverjon L., 2018. Ann. Bot., 121(5). DOI: 10.1093/aob/mcx154; Oerke E.-C., 2006. J. Agric. Sci., 144 (1), 31-43. DOI: 10.1017/S0021859605005708; Queyrel W. et al., 2023. Agric. Syst., 208 (6), 103645. DOI: 10.1016/j.agry.2023.103645; Ritchie J.T., 1998. Springer Netherlands, p. 41-54. DOI: 10.1007/978-94-017-3624-4\_3; Xu Z. et al., 2021. Sci. Data, 8 (1), 293. DOI: 10.1038/s41597-021-01079-3

**Perspectives:** Determine the characteristics of future weed floras for better management

