CLIMATE-SMART Agriculture 2015

Global Science Conference

March 16-18, 2015
Le Corum, Montpellier France

Breeding for sunflower hybrids adapted to climate change: the SUNRISE collaborative and multi-disciplinary project

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Montpellier

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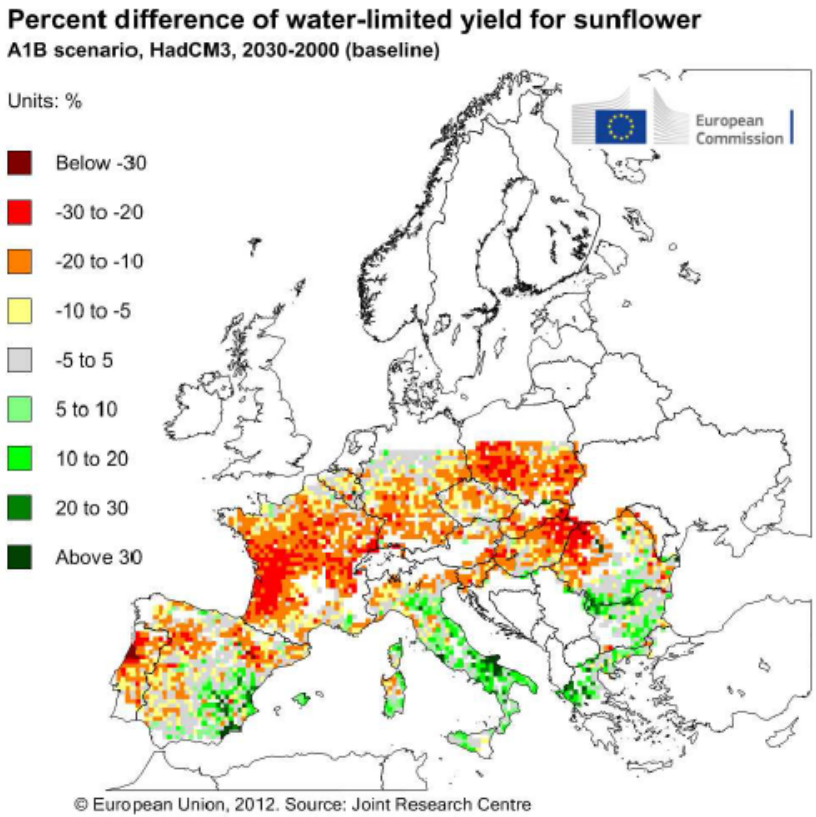
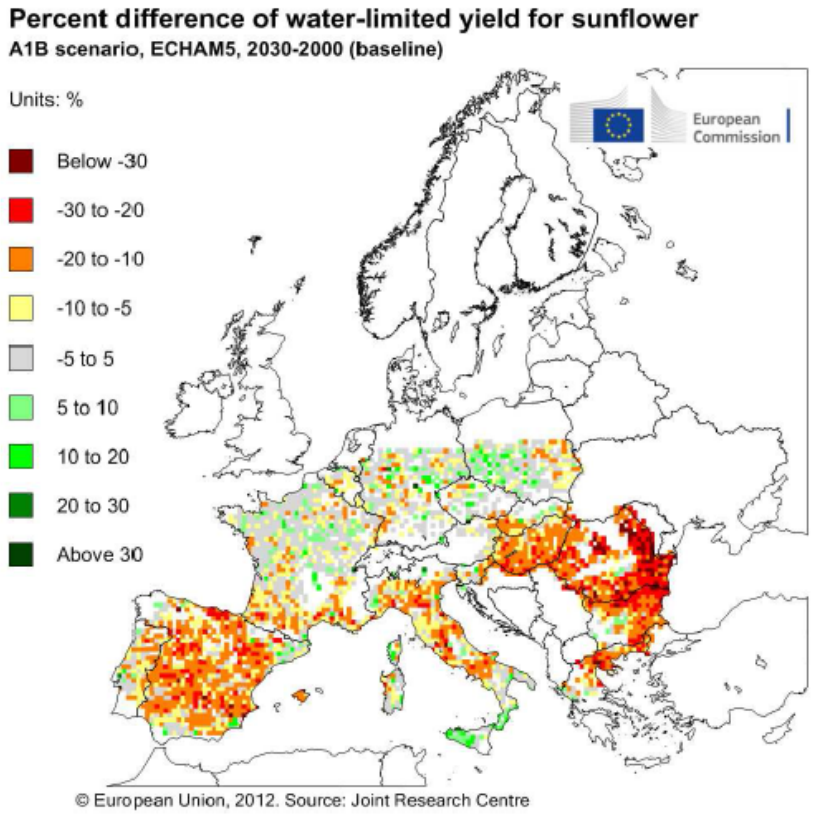
CropSyst model - A1B scenario – 2 climatic models





Sunflower yield losses of 10 to 30 % have been predicted at 2030 horizon in Europe due to increasing water deficit and cycle shortening

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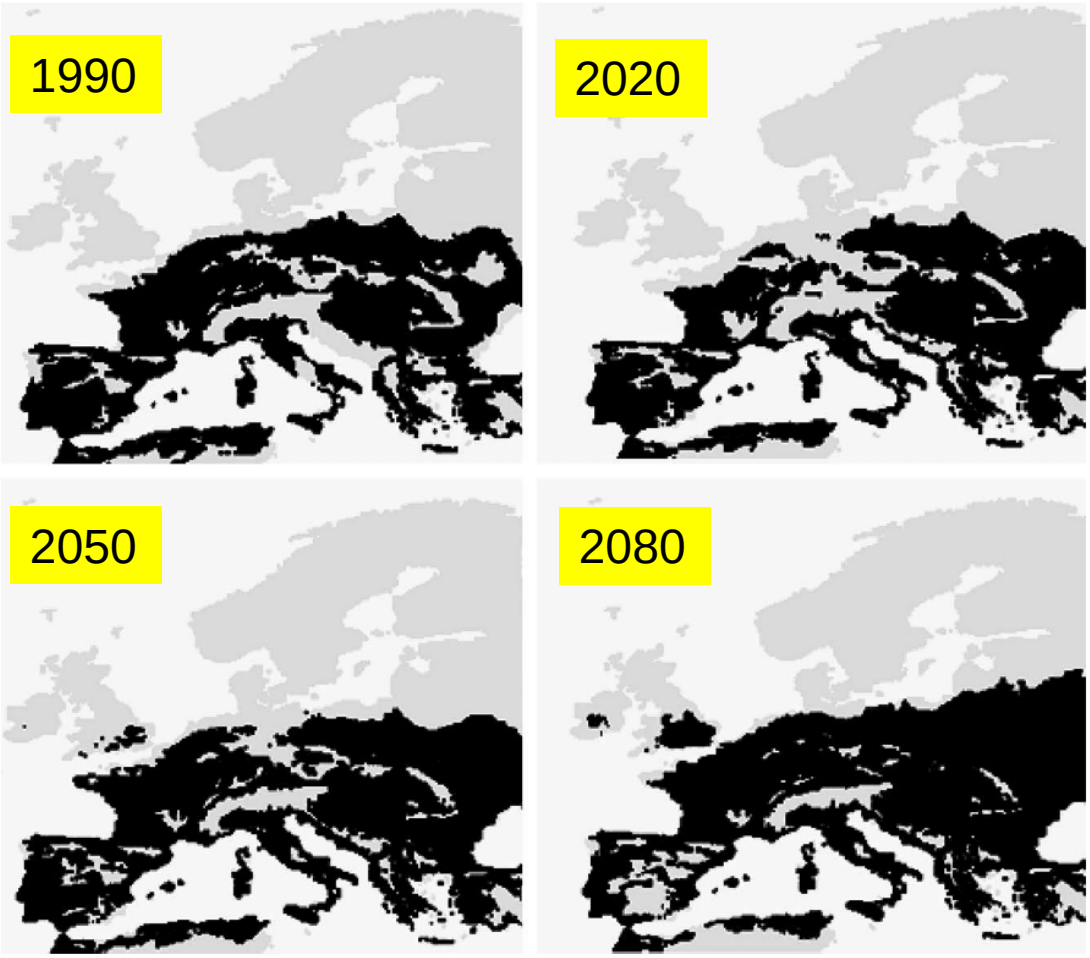
Donatelli et al. (2012) – AVEMAC project



HadCM3 climatic model - A2 scenario

Climate suitability maps indicate new opportunities for sunflower cropping in septentrional Europe

Tuck et al. (2006) *Biomass & Bioenergy*

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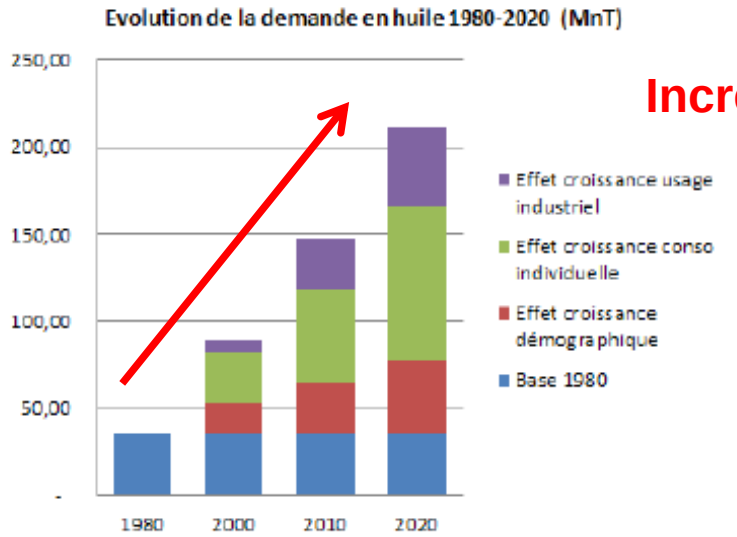
The Crop

Agronomic & environmental benefits for agro-ecological and climate-smart cropping systems :

- Low input (pesticides, nutrients, irrigation)
- Relative drought resistance, plasticity
- Summer break crop in winter cereal systems

Growing markets, sure outlets

- Edible oil (oleic, linoleic), green chemistry, animal feeding (protein cakes), biodiesel



Increasing oil demand

Industry
Consumption
Demography

> 200 M t oil at 2020 horizon

Source : Sofiproteol

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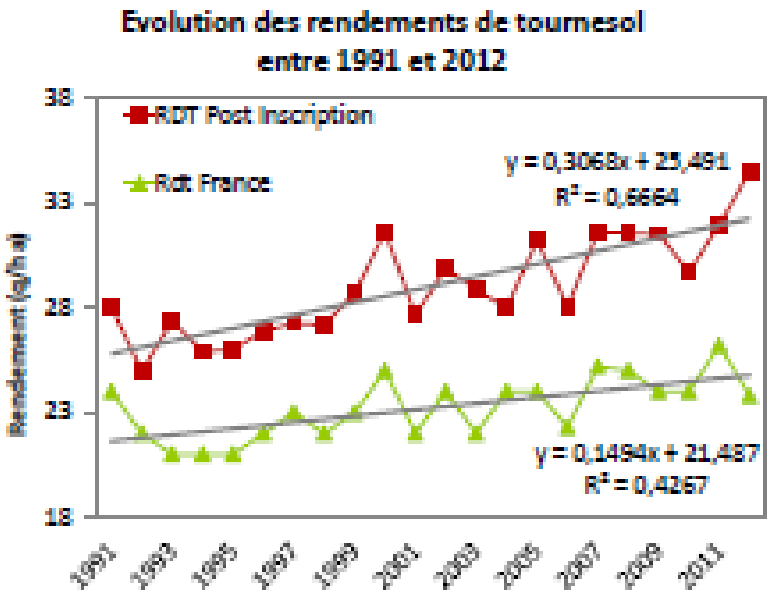


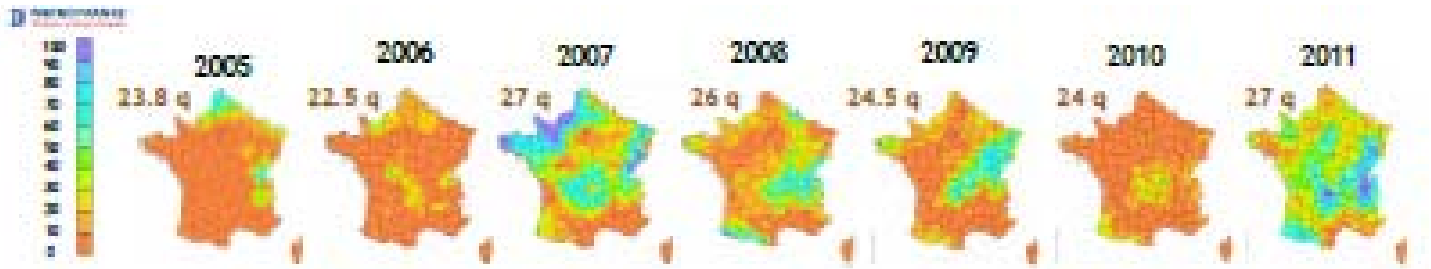
Yld gap

Only slight yield improvement observed at farm level (France)

Post-registration trials : 0.031 t.ha^{-1}

Farmers : 0.015 t.ha^{-1}

SWC on 21 July (ASWC = 100 mm)



Sunflower yield is strongly related to actual soil water content at flowering (July) and to total available SWC

Source : CETIOM

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SUNRISE project (2012-2019)

SUNRISE
UNE CULTURE POUR LE FUTUR

SUNflower Resources to Improve yield Stability in a changing Environment

investment 21.7 M€

7 private partners, INRA & 2 universities

biogemma
SOLTIS
INRA SCIENCE & IMPACT
CAUSSADE semences
R·A·G·T 2n
MAÏSADOUR semences
syngenta SEEDS
LEREPS
UPMC SORBONNE UNIVERSITÉS
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CETIOM Centre Technique Interprofessionnel des Oléagineux Métropolitains

http://www.sunrise-project.fr

SUNRISE associates several approaches:

(i) the sequencing and genotyping of the **genetic diversity among cultivated and wild sunflowers**

(ii) the development of appropriate and **high-throughput phenotyping** strategies to characterize the molecular, physiological and agronomical responses to variation of the abiotic environment,

(iii) the discovery through genome-wide association, linkage mapping and genomic selection of the genetic factors involved in those responses

(iv) the integration of this genetic knowledge into a **crop model (SUNFLO) to test *in silico* G by E interactions and design promising ideotypes in future environments**

(v) the evaluation of the outputs for the breeding sector and the transfer of knowledge to agriculture.

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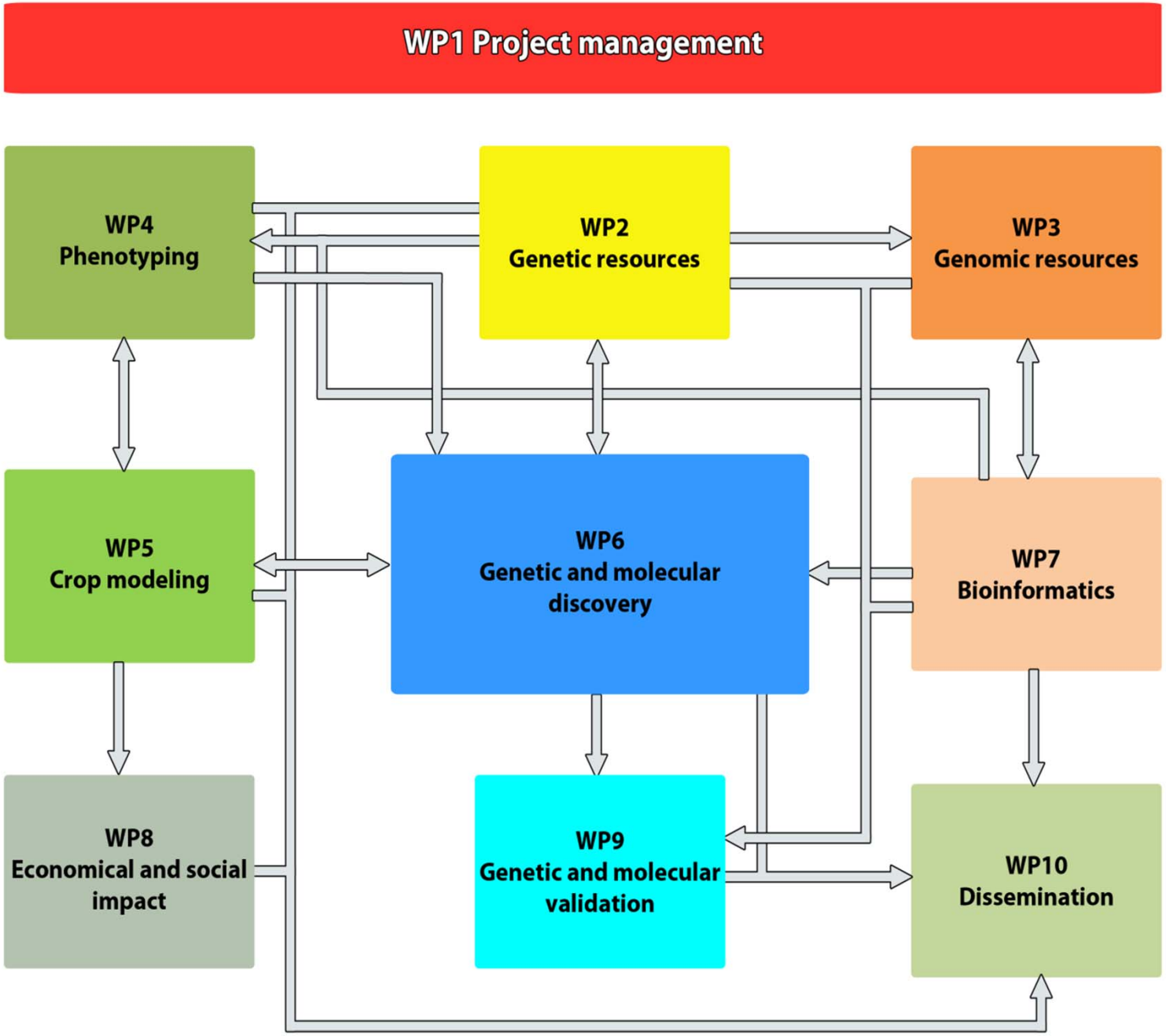
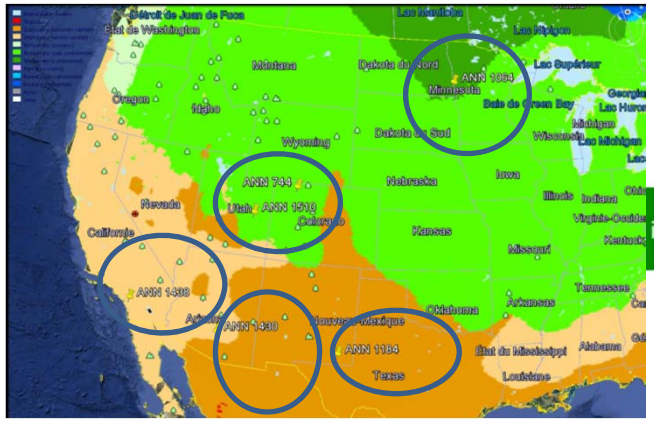

WP1 Project management
WP4
Phenotyping
WP2
Genetic resources
WP3
Genomic resources
WP5
Crop modeling
WP6
Genetic and molecular discovery
WP7
Bioinformatics
WP8
Economical and social impact
WP9
Genetic and molecular validation
WP10
Dissemination

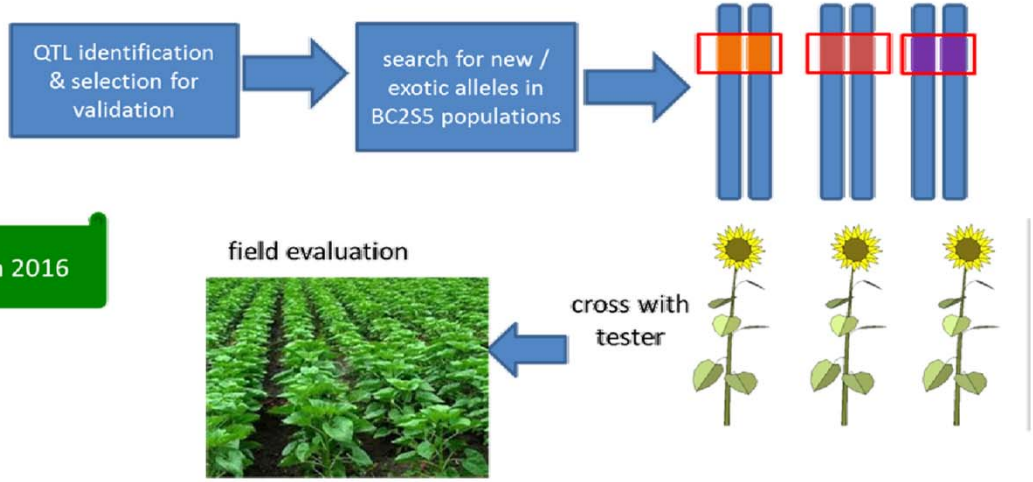
First achievements : Genetic resources

- Germplasm development for discovery and validation (hybrids, RILs...)
- **Genetic variability enhancement**
  → Use of wild *Helianthus* from the USA

Development of 5 populations of Introgression Lines from wild *H. annuus* * XRQ crosses (allelic diversity platform)



in 2016



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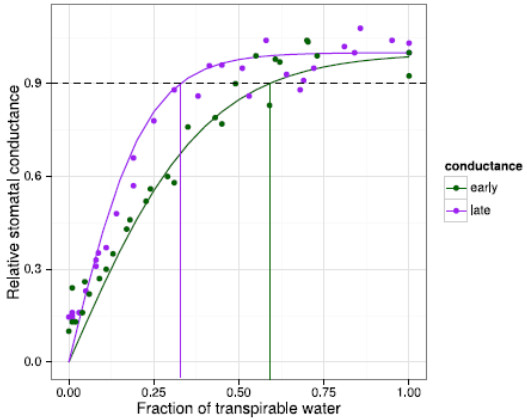
First achievements : Phenotyping

- **Multi-environment trials** with basic, fine or advanced phenotyping (France, Europe) on a range of edaphic conditions
- High-throughput field phenotyping with drones (UAV)
- Outside pot platform with **controlled water stress and weighing robot** (Heliaphen)



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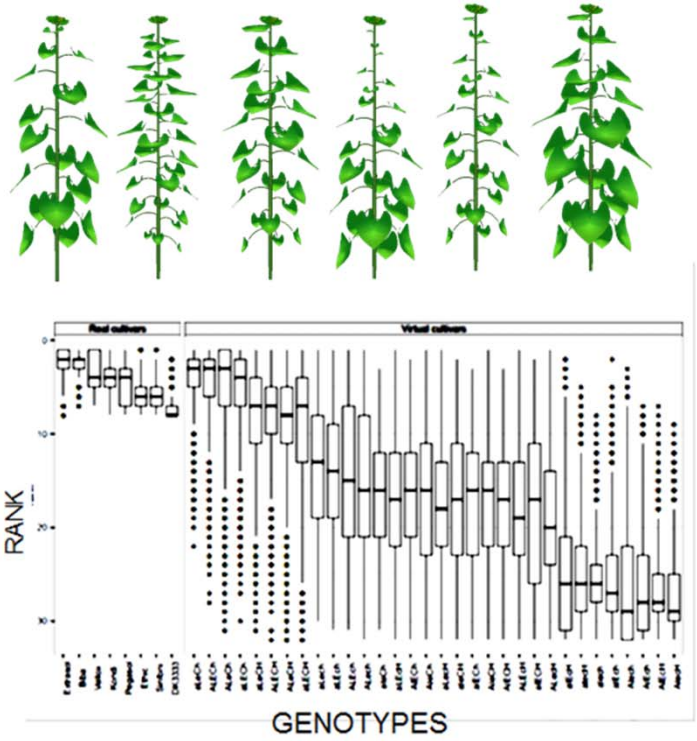
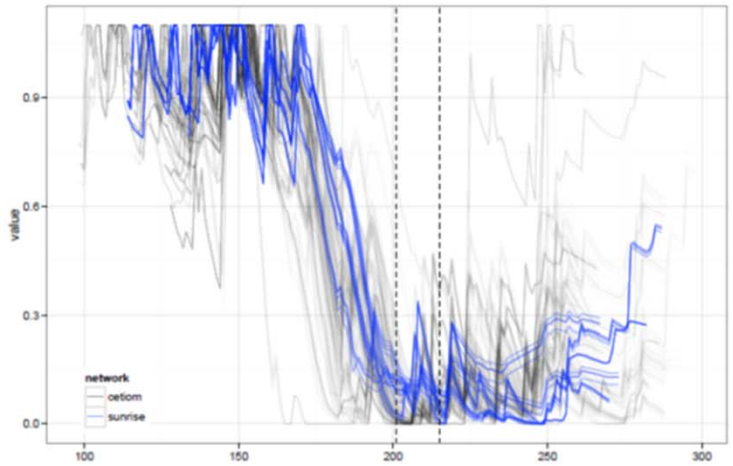
First achievements : Crop modeling

- **Simulate drought patterns** on METs with SUNFLO crop model (Casadebaig *et al*., 2011)
- **Design future ideotypes** by combining optimization and simulation procedures



Transpirable Soil Water (%) = f(t)



Simulation of virtual and actual genotypes

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Main features of the SUNRISE project

- Develop a “crop for the future” : climate change (drought), ideotypes, allelic diversity, new domestication ?
- Integrative research : agronomy, genetics, genomics, ecophysiology, economy, computing science and applied mathematics

  → e.g *characterize the genetic architecture of crop model parameters ; optimize ideotyping*
- Focus the public-private partnership in Toulouse for more international visibility

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Acknowledgements

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