Sorghum ID

Sorghum: the safe bet for the future

Designing multi-criteria sorghum ideotypes in changing climate and societal contexts: implications for plant phenotyping and modelling

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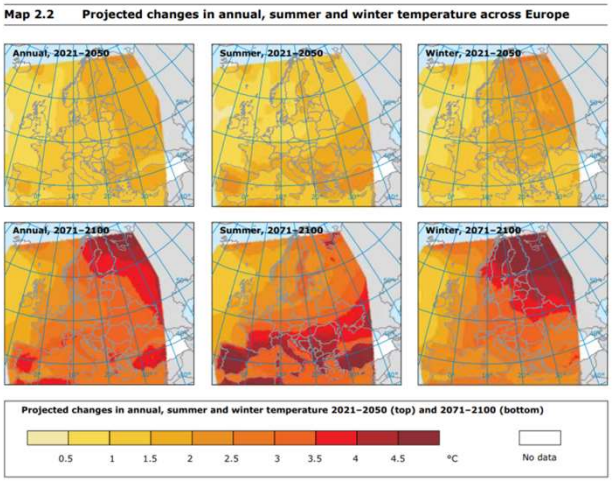
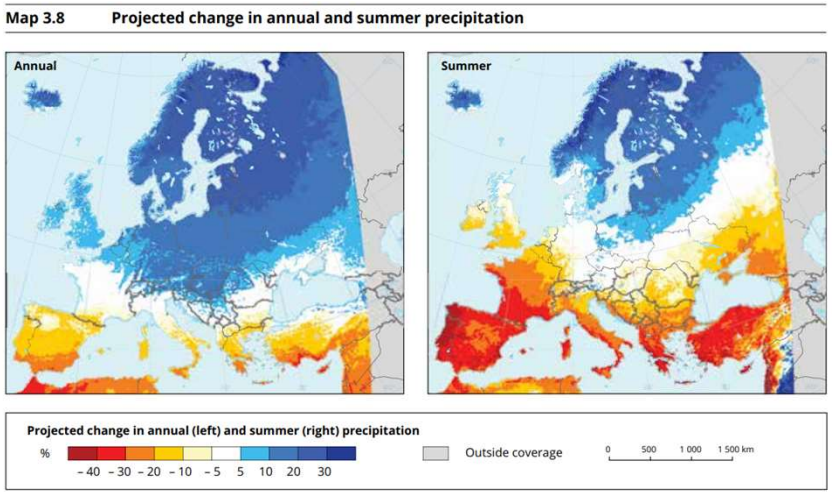
OUTLINES

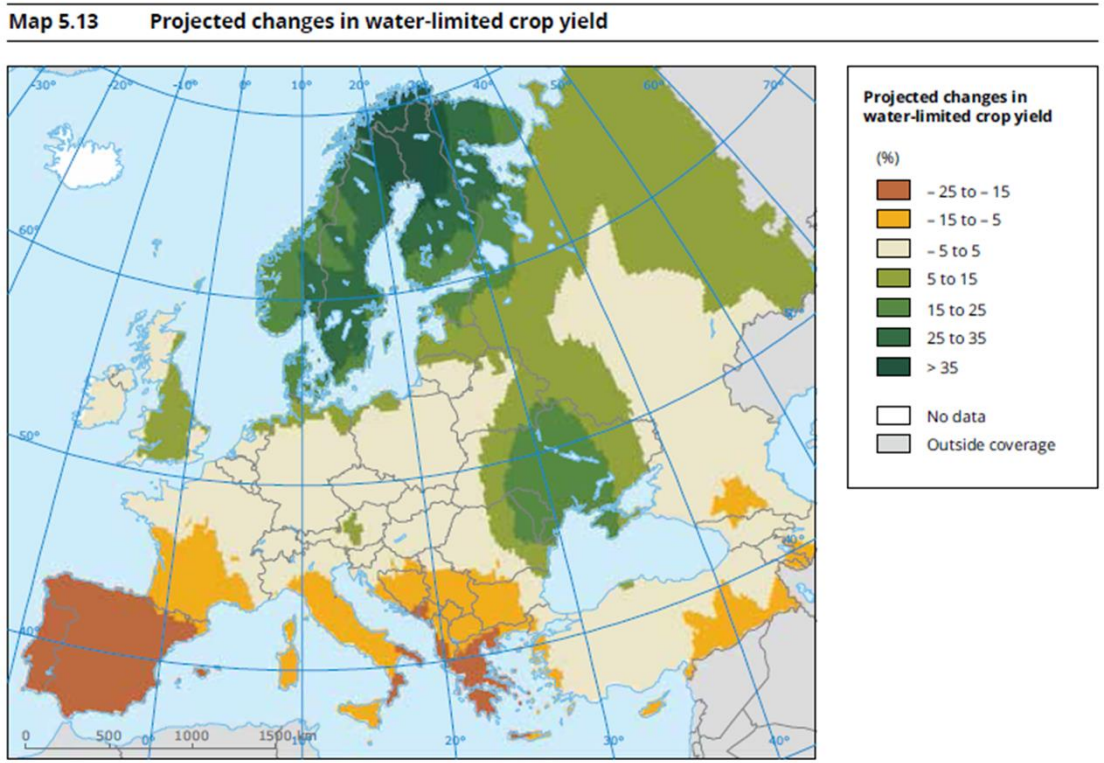
1. *Current & future challenges for Agriculture in Europe*
2. *Need for multiple & multi-criteria ideotypes: a role for sorghum*
3. *Implications for sorghum crop physiology - Some recent examples*
4. *Phenotyping challenges: complementarities to be valorized in a network*
5. *Role of crop modelling: predict optimal GxExM interactions & ideotypes*
6. *Outlooks*

CURRENT AND FUTURE CHALLENGES FOR AGRICULTURE

- ***Climate change impact on spring/summer crops***



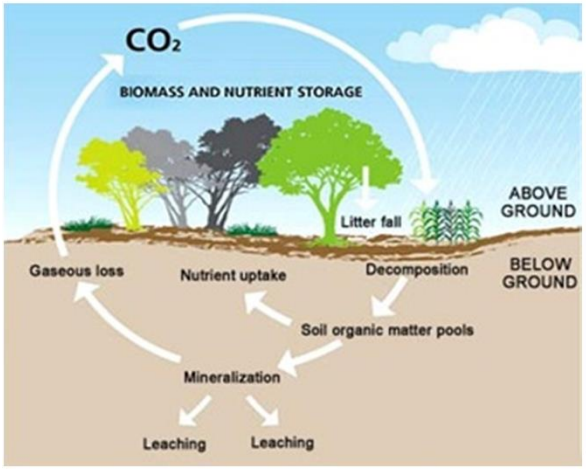


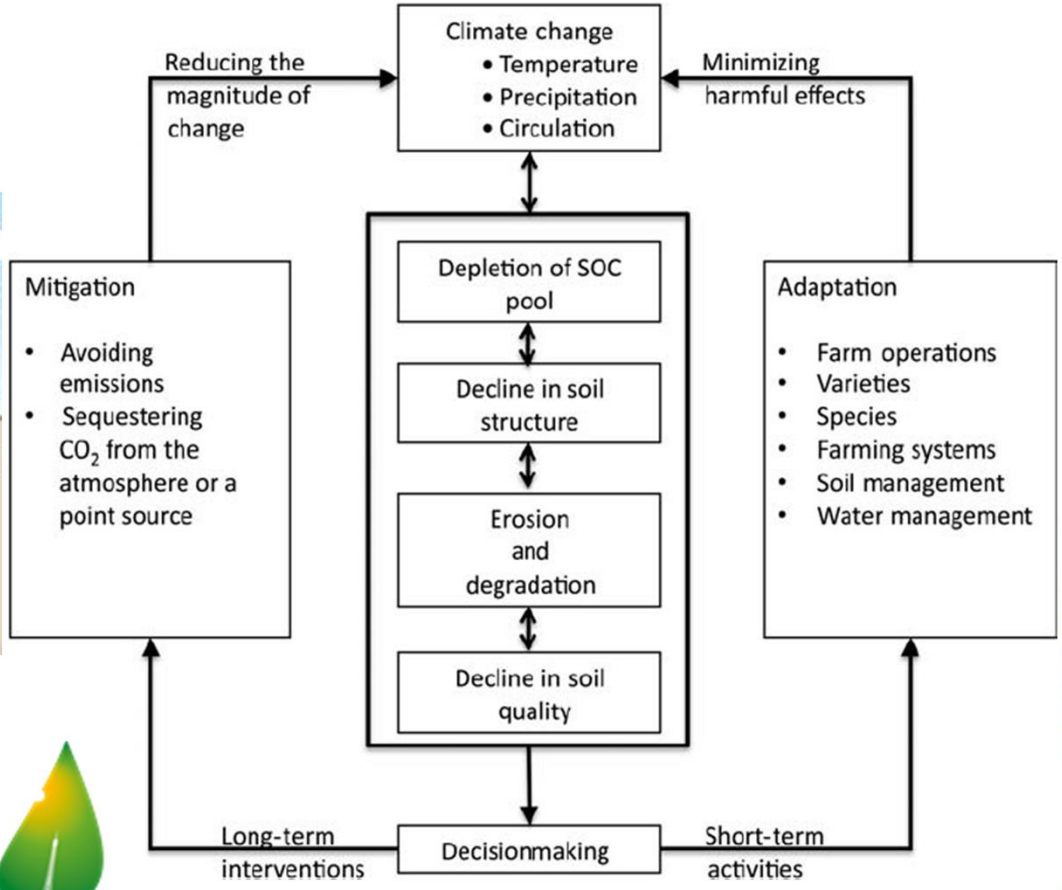


EEA Report 1/2017

CURRENT AND FUTURE CHALLENGES FOR AGRICULTURE

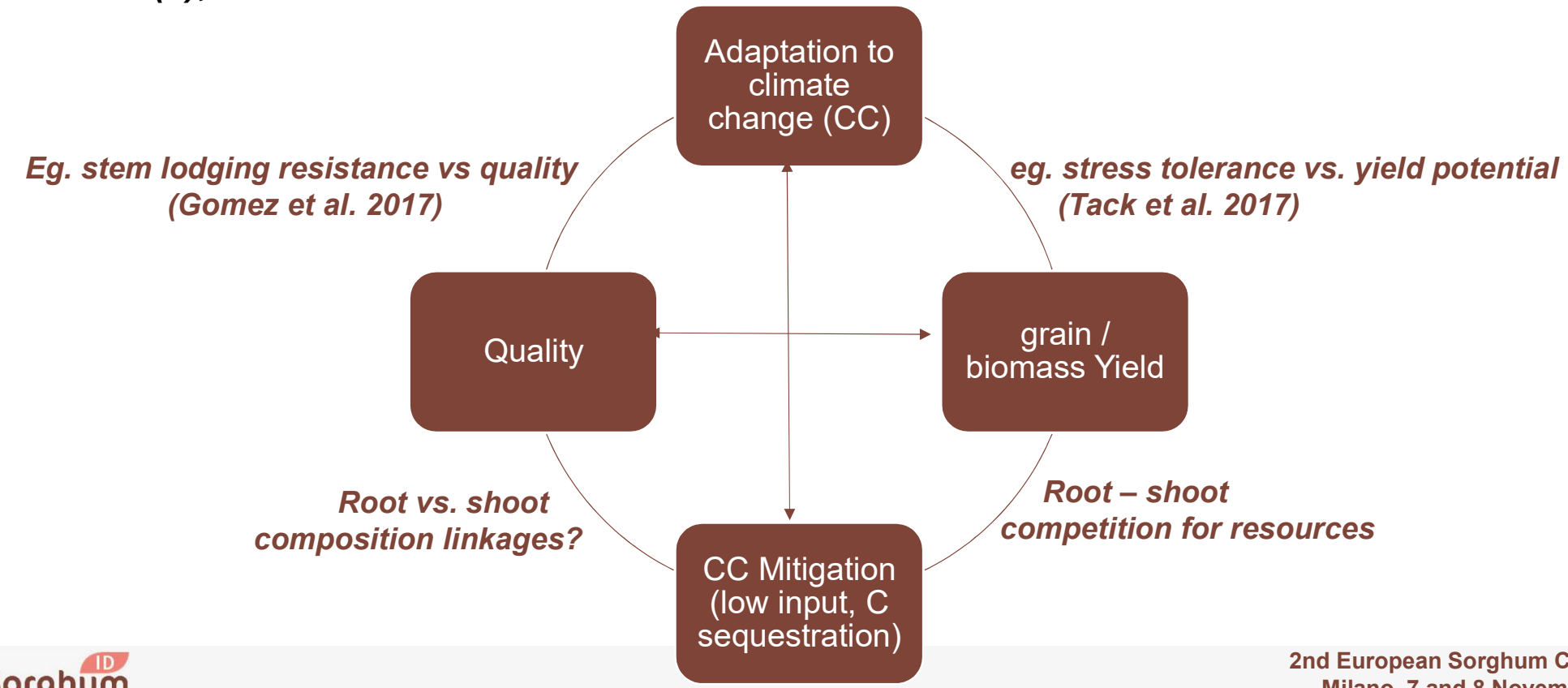
- ***adaptation to future climatic scenario: are we ready?***





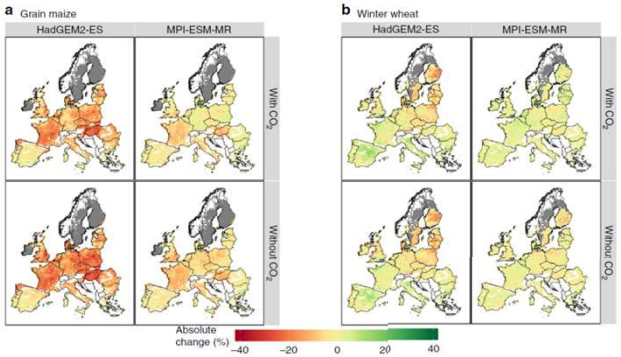
CHALLENGE OF MULTIPLE AND MULTI-CRITERIA IDEOTYPES

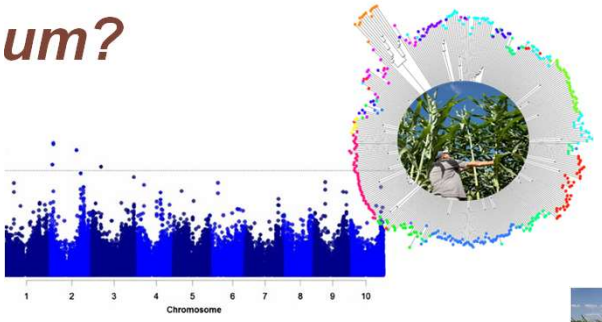
- ***Trait packages** : **production X stability (adaptation), multi-purpose** crops…*
- ***Trait linkage** (covariation, trade-offs): opportunity or limit to breeding*
- ***Which trait(s), where / when?***

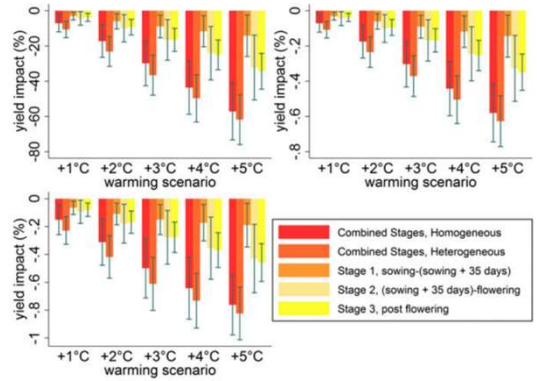


CURRENT AND FUTURE CHALLENGES FOR AGRICULTURE

- *An increasing role for sorghum?*

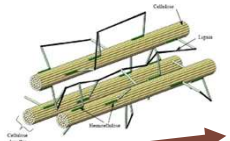


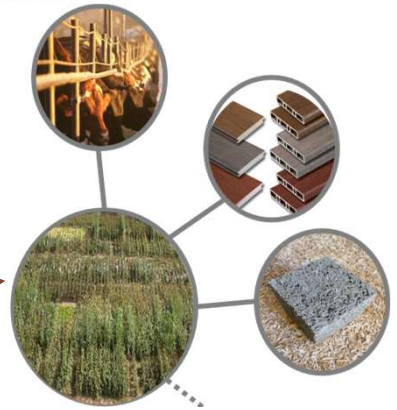




Genetic diversity

Adaptations





Multipurpose

Vadez et al. 2011; Tack et al. 2017

SORGHUM CROP PHYSIOLOGY IN A PRE-BREEDING CONTEXT

Which trait(s) for what?

End-Uses

Adaptation

Mitigation

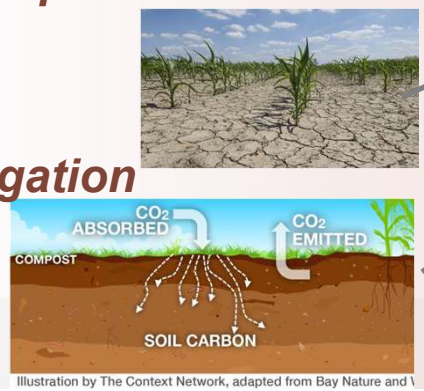
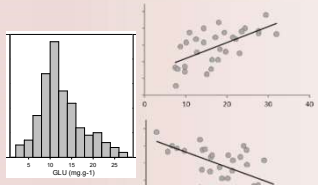
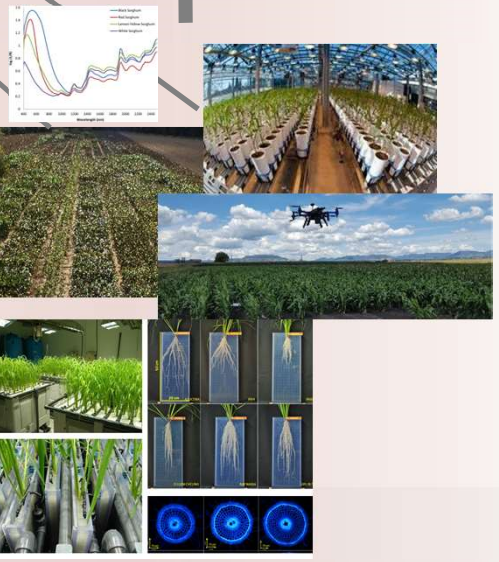


Illustration by The Context Network, adapted from Bay Nature and

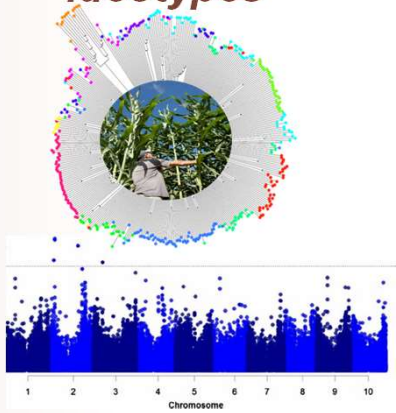
Phenotyping
Diversity, co-variations





Insight for breeding?

Traits, alleles, genes, ideotypes

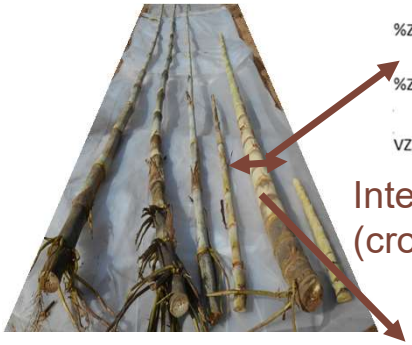


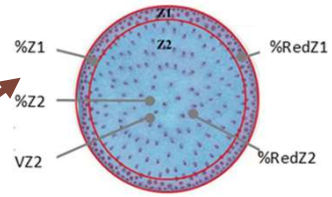
For targeted end-uses & environments

RECENT EXAMPLE - *BIOMASS FOR THE FUTURE PROJECT* (1)

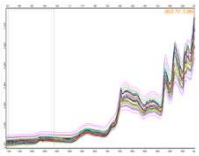
Internode histochemical traits impact on industrial properties & phenotyping challenge

Field study over 8 (biocomposites) to 24 (methanisation), 3 sites in 2013 in Southern France





Internode histological traits
(cross section staining)



NIRS prediction of
stem biochemical traits

Industrial properties related to genetic variability of these traits

Methanisation (BMP)

	BMP Nml/gMS
adlSndf	-0.62
hemiSndf	0.50
Perc_BlueZ2	0.55
SMS	0.57
IVNDFD	0.62

Biocomposite (eg. elasticity)

	Young Modulus
SMS	-0.84
SMO	-0.84
Sugars	-0.66
Perc_BlueZ2	-0.53
Perc-SclZ1	0.64
ADL	0.77
NDF	0.81
ADF	0.86
CBW	0.87

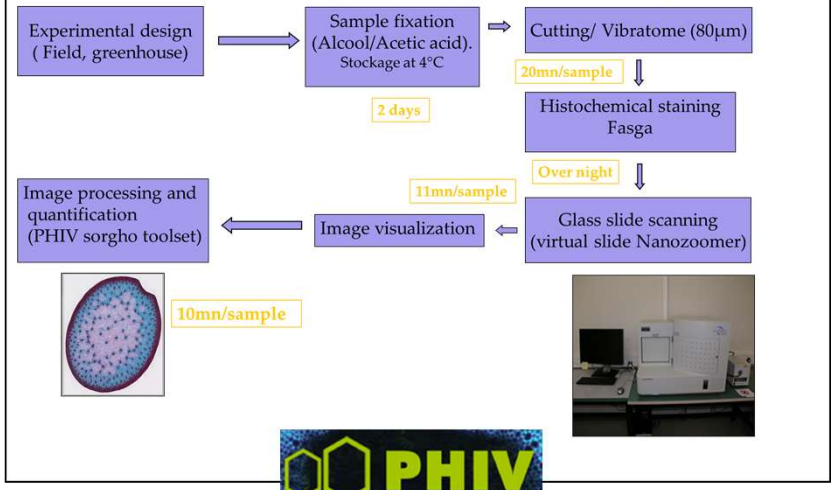
➔ Challenge of **phenotyping existing genetic diversity** to dissect the genetic architecture of these traits

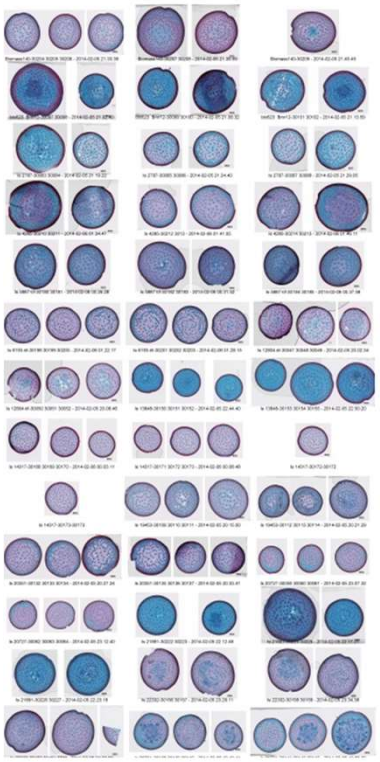
Jaffuel et al. *2018 Sorghum international conference South Africa*
Carrere *et al. Waste and Biomass Valorization, 2017*

RECENT EXAMPLE - *BIOMASS FOR THE FUTURE PROJECT* (2)

Development of phenotyping pipelines: increase the throughput and the traits captured

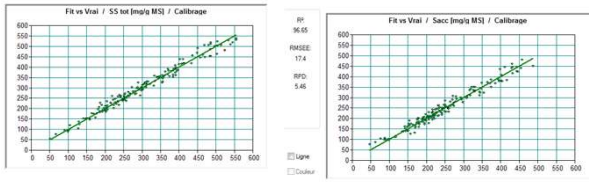
Histology phenotyping pipeline





NIRS phenotyping

Lignin
(Hemi)Cellulose
Sugars
….



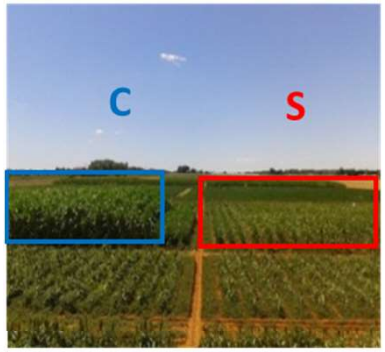
Valorized in **Multi-site phenotyping for GWAS**
Eg. NIRS (Vilnius et al. under prep.)

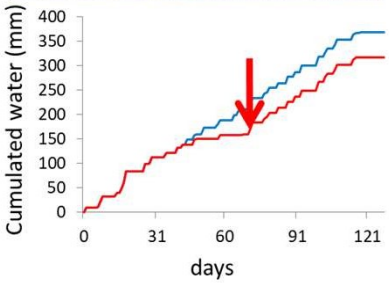
Verdeil et al. under prep. ; Jaffuel et al*. 2018 Sorghum international conference, South Africa*

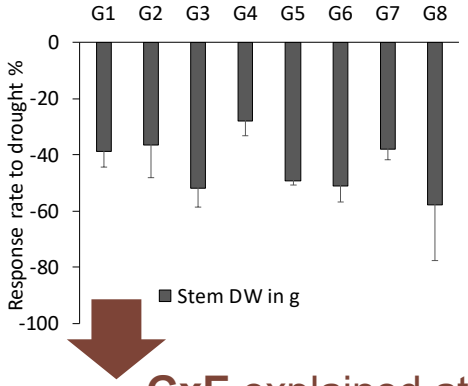
RECENT EXAMPLE - *BIOMASS FOR THE FUTURE PROJECT* (3)

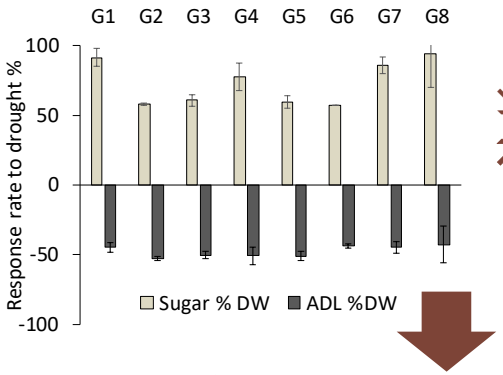
Genotypic response to water availability of stem biomass production & properties

8 genotypes - 2 field water treatments – 2013-2015 (France)



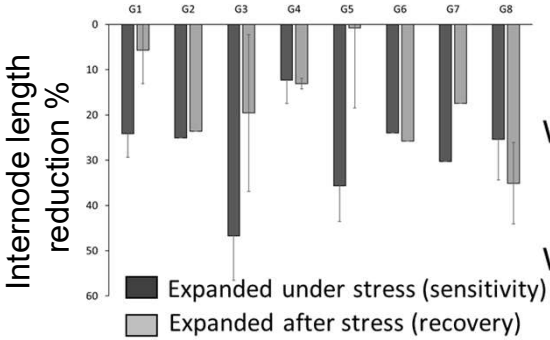


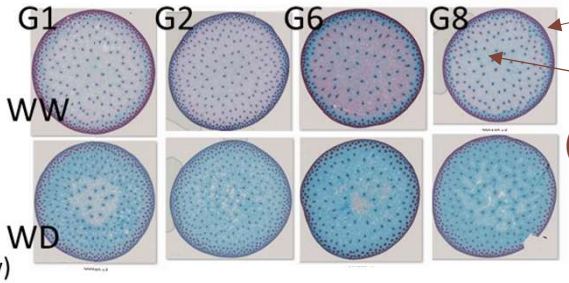




↘ **stem growth & [lignin],**
↗ **[sugar]**

GxE explained at internode & tissue level





sclerenchyma

parenchyma

(Lignin stained in red)

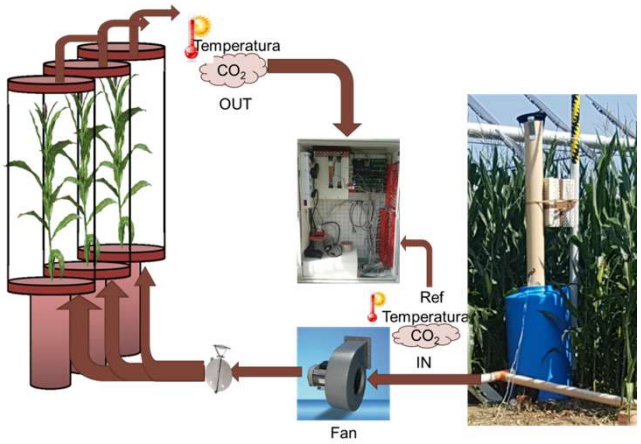
➔ **Trait package to be phenotyped on populations / panels under water deficit**
➔ **Toward their genetic study and valorisation in a breeding context**

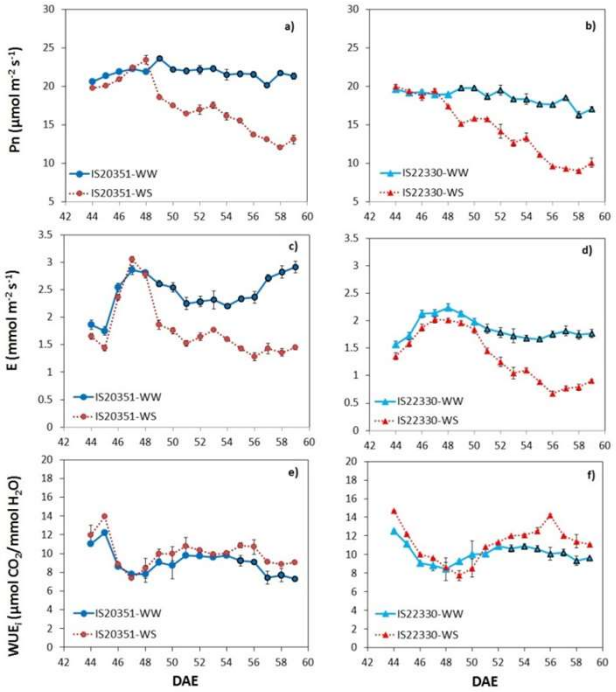
Sorghum ID

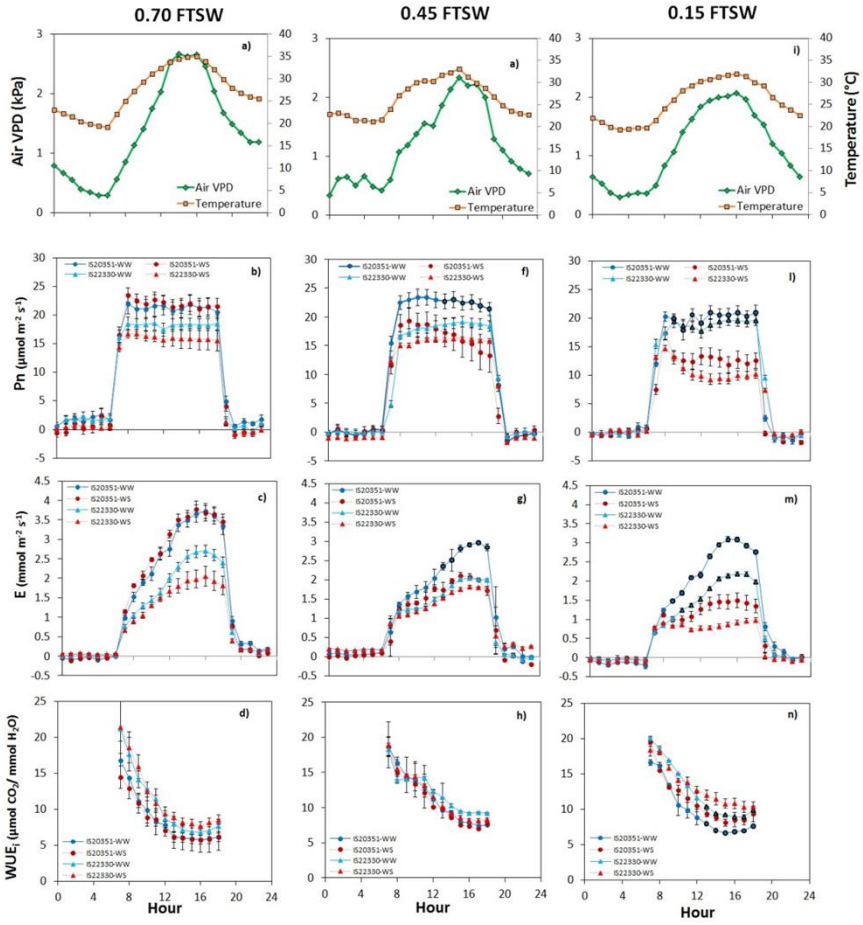
Perrier et al. 2017 Frontiers; Luquet et al. GCB bioenergy

cirad

A RECENT EXAMPLE – PHENOTYPING FOR DROUGHT TOLERANCE







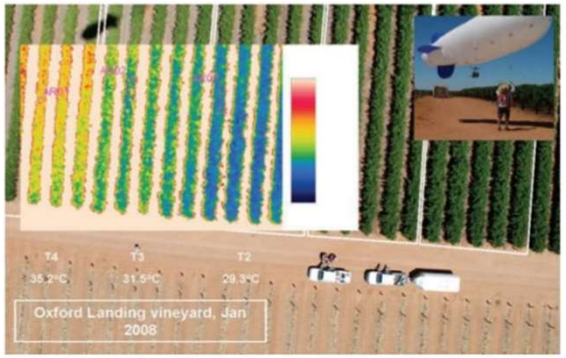
Sorghum ID

Fracasso et al., 2017 Frontiers

A RECENT EXAMPLE – PHENOTYPING FOR…AT DIFFERENT SCALES

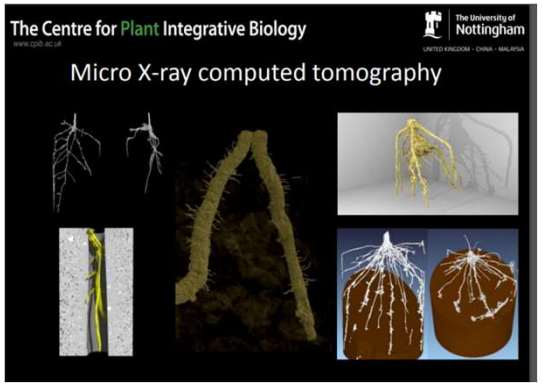
Lab phenotyping

Field phenotyping

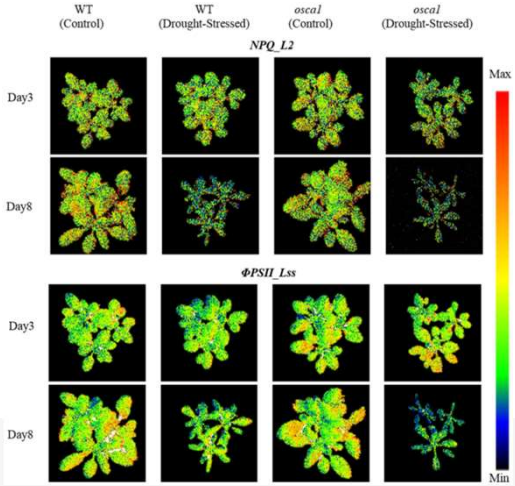


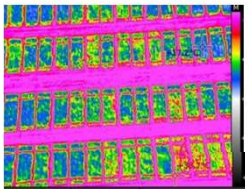
Mean canopy temperatures of three areas of crop corresponding to three irrigation treatmen (T2, T3 and T4 with decreasing amounts of irrigation applied)

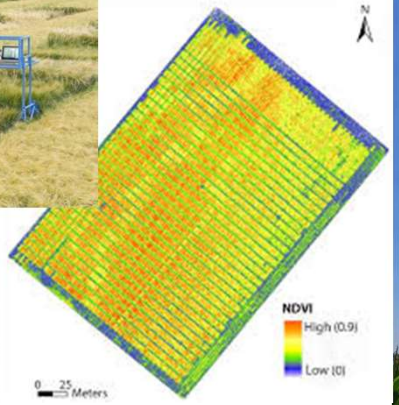
Root architecture



Chlorophyll fluorescence





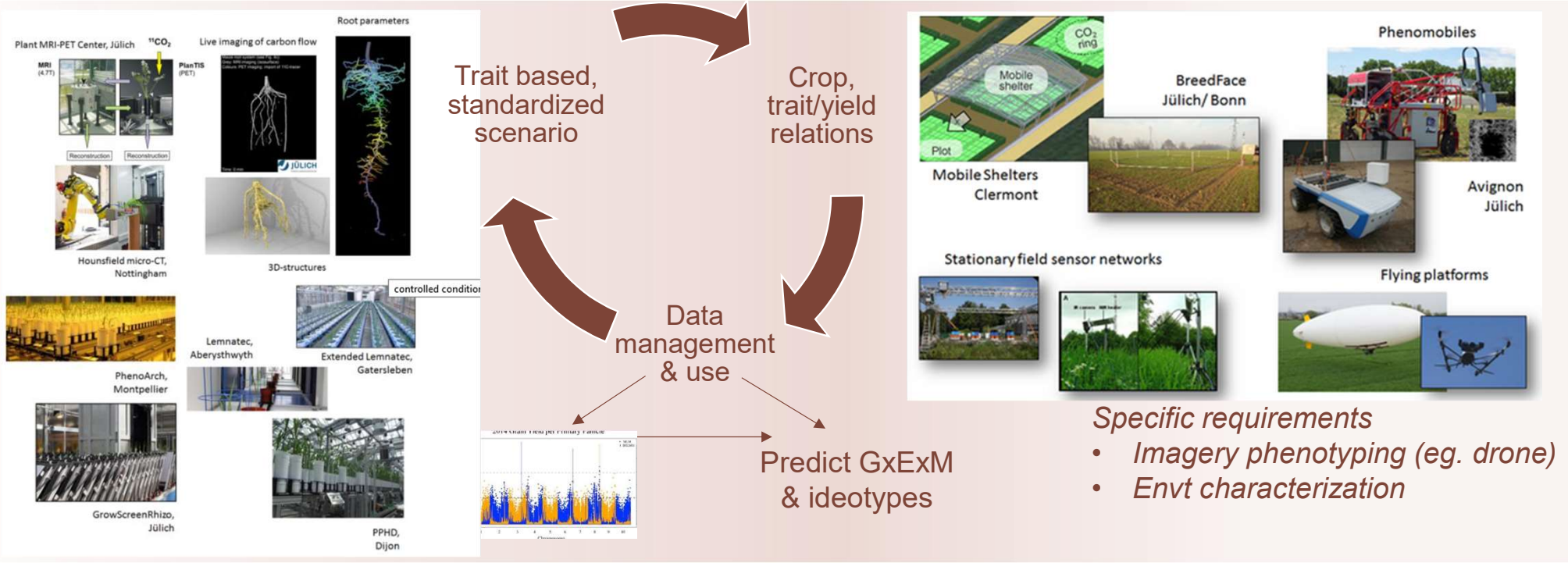


Sorghum ID

MO. RE. FARMING
A MONITORING & REMOTE SYSTEM FOR A MORE SUSTAINABLE FARMING

2nd European Sorghum Congress 2018

CONTROLLED ENVIRONMENT VS. FIELD PHENOTYPING:
COMPLEMENTARITY & IMPLICATIONS (TOOLS, DATA MANAGEMENT AND USE)



Specific requirements

- *Imagery phenotyping (eg. drone)*
- *Envt characterization*

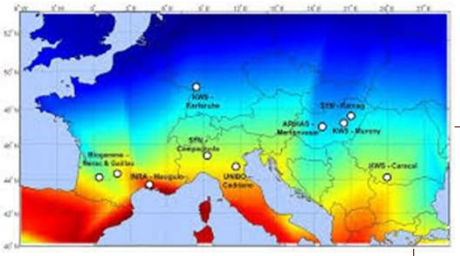
European Plant Phenotyping Network
EPPN

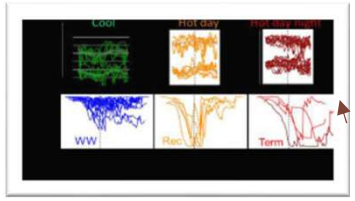
EMPHASIS

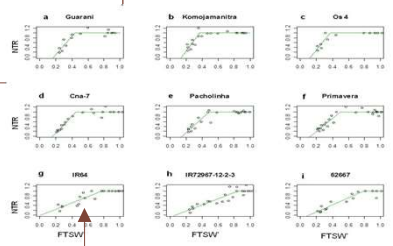
Innovation in breeding in WA
***Sorghum** as a pioneer crop*

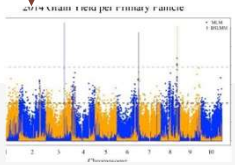
Dispositif en Partenariat dP | iavao

CROP MODELLING:
INTEGRATING KNOWLEDGE, OPTIMIZING GxExM & IDEOTYPING

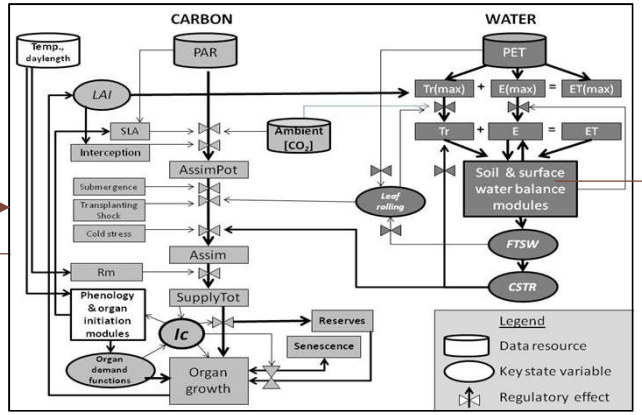


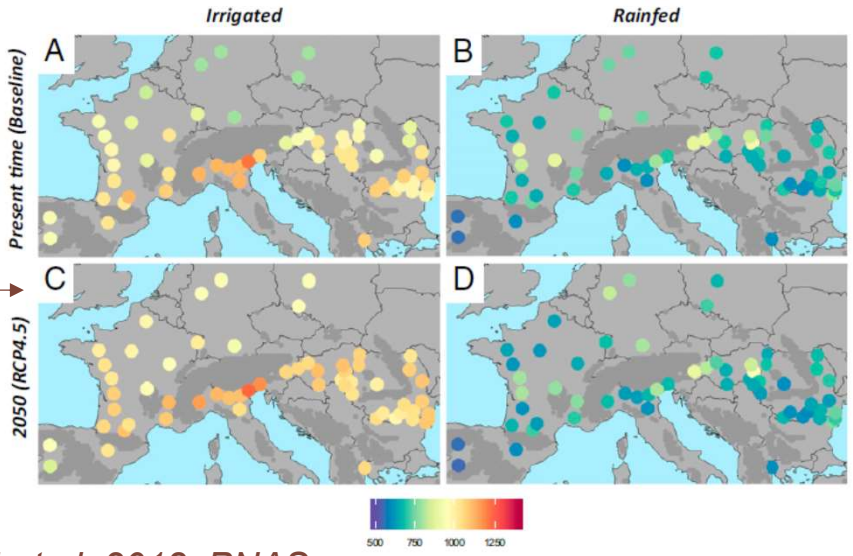






Crop Model





Parent et al. 2018, PNAS
Modeling optimal cycle duration (parameter) in maize
Sowing date according to current's farmer strategy

➔ **Models and sites are available for sorghum**
(biomass, grain, multi-purpose; Adam et al 2017; Luquet et al. 2018)
➔ **Opportunity for innovation in support to sorghum breeding**

OUTLOOKS: WHAT IS WORTH BEING COMBINED

- **Biological understanding of multicriteria ideotypes** (end-uses, sustainability, adaptation…): **trait packages**
- **Trait diversity & genetic determinisms** combining controlled env & field phenotyping
- **Crop modelling**: integrate knowledge & support **ideotype & trait impact evaluation** for current & future climatic scenario
- **Partnership, networks, facilities in Europe** to be valorized for sorghum