Use of a crop growth model for supporting variety choice in sunflower

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[2] Terres Inovia
[3] GEVES

18th Congress of the European Society for Agronomy in Rennes, France
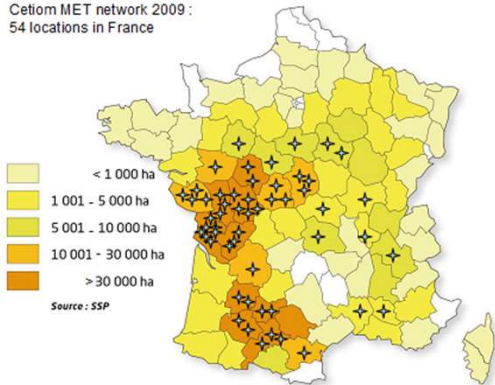
Value for Cultivation & Use (VCU) is mainly based on multilocal field experiments (or multi-environment trials, METs)

Microplots, trials
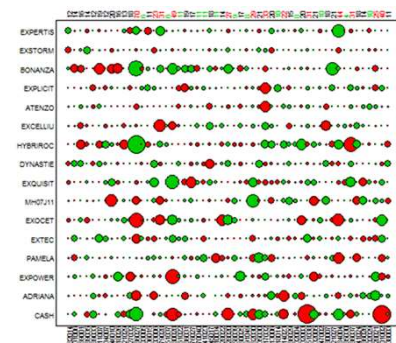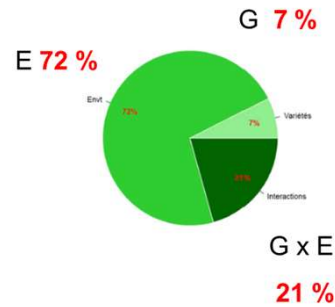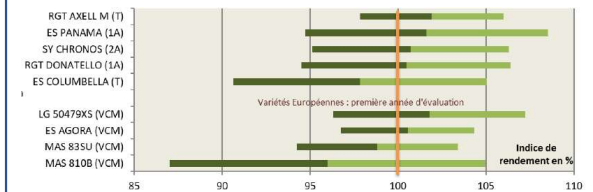
Cetiom MET network 2009 : 54 locations in France

< 1 000 ha
1 001 - 5 000 ha
5 001 - 10 000 ha
10 001 - 30 000 ha
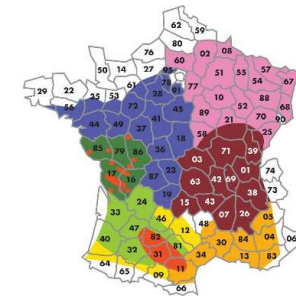> 30 000 ha
Source : SSP

METs, national reference network

$$Y_{ijk} = \mu + G_i + E_j + GE_{ij} + e_{ijk}$$

G **7 %**

E **72 %**

G x E

21 %

Statistical and graphical analysis (G x E...)

Official publication (variety ranking)

Regional recommendations

INRAE   Terres Inovia   GEVES

Assessing varieties exclusively from METs may have shortcomings

- **Reduced climatic variability** (drought, diseases...): 2-3 years to evaluate a variety in the Official Variety Testing Networks

- **Biased representation of soils and crop practices** (e.g. deep soils, best management...)

- **Reduced number of VCU criteria**, especially for scoring the abiotic tolerance of varieties (e.g. drought)

- **Poor environmental characterization** of trial sites (e.g. abiotic stresses)

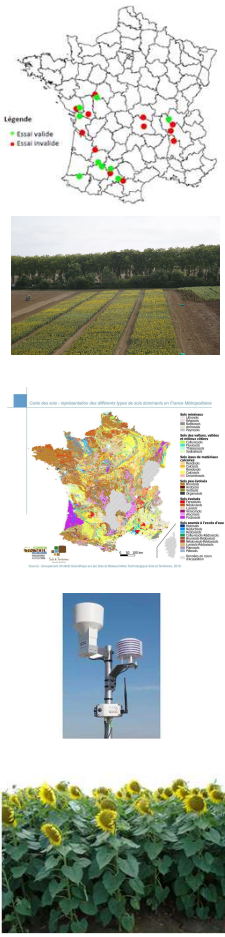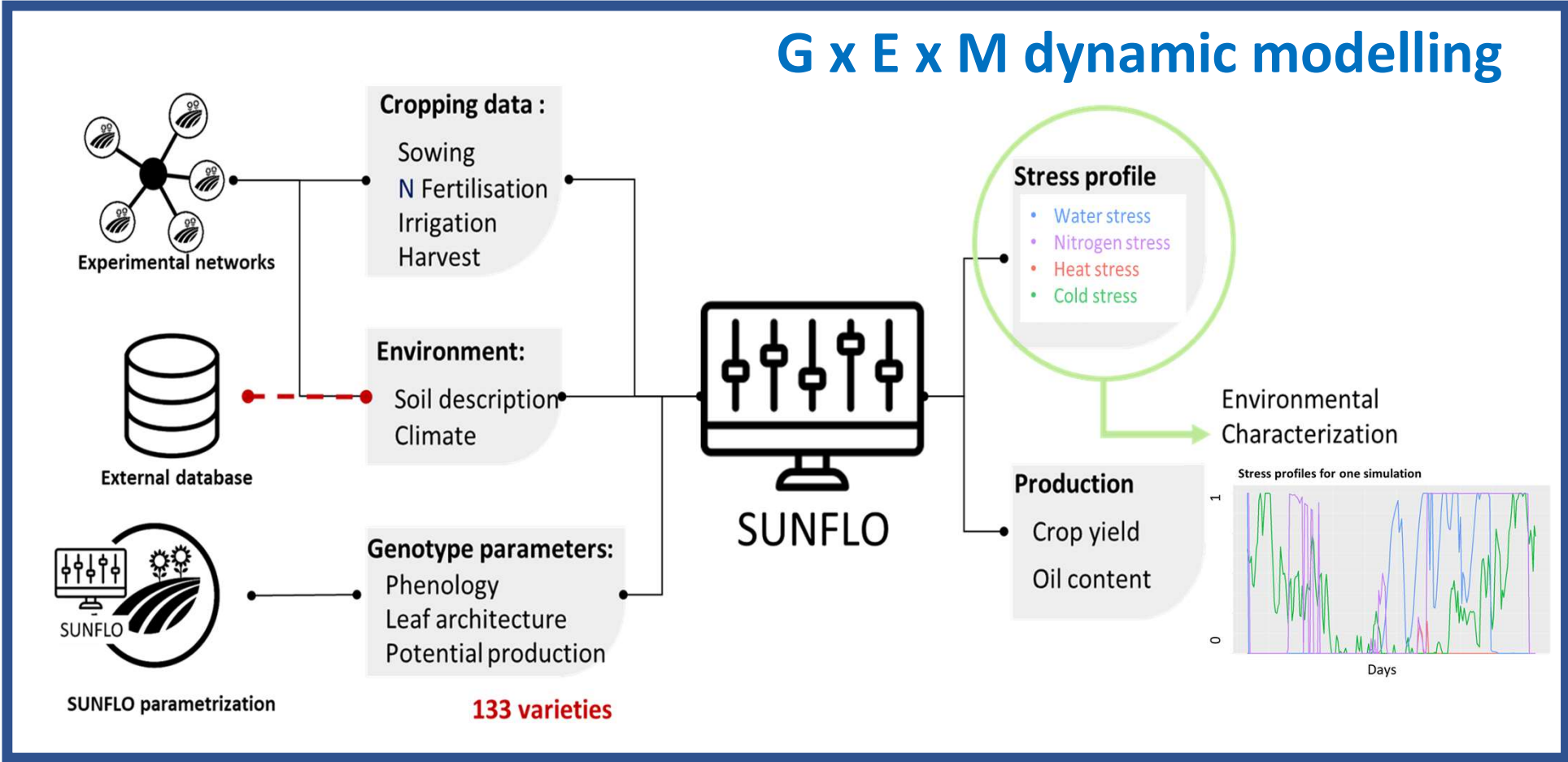- **No direct use for variety x management recommendations**

Debaeke *et al*. (2011), *Innov. Agron. ;* Casadebaig *et al.* (2016), *EJA*

G x E x M dynamic modelling

Cropping data :

Sowing
N Fertilisation
Irrigation
Harvest

Environment:

Soil description
Climate

Genotype parameters:

Phenology
Leaf architecture
Potential production

133 varieties

Experimental networks

External database

SUNFLO parametrization

SUNFLO

Stress profile

- Water stress
- Nitrogen stress
- Heat stress
- Cold stress

Environmental Characterization

Production

Crop yield
Oil content

Stress profiles for one simulation

Days

Casadebaig *et al* (2011), *AFM*
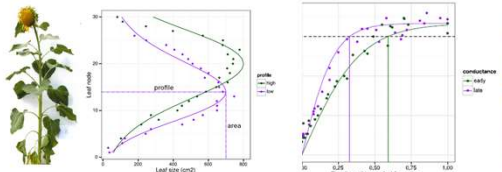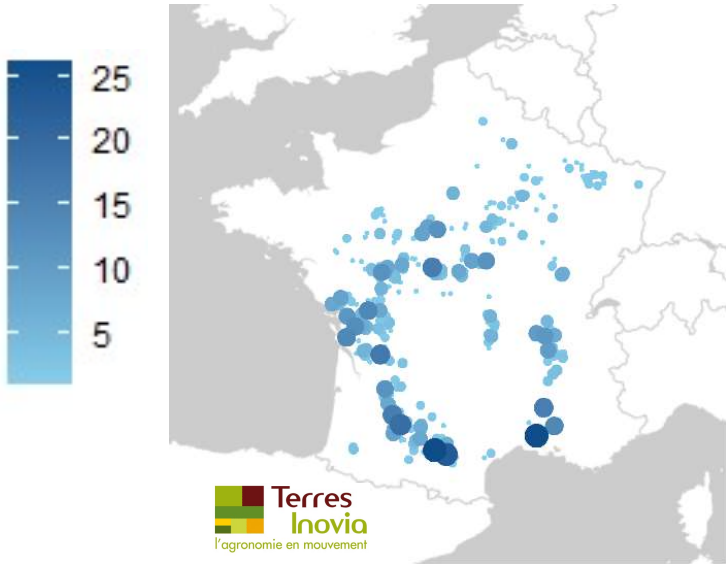
Phenotyping facilities

Architecture de la plante
Distribution spatiale de la surface foliaire (champ, potentiel)

INRAE   Terres Inovia l'agronomie en mouvement   GEVES

METs 2003-2020

Yield prediction at variety level

1431 trials
Validated : 81 %
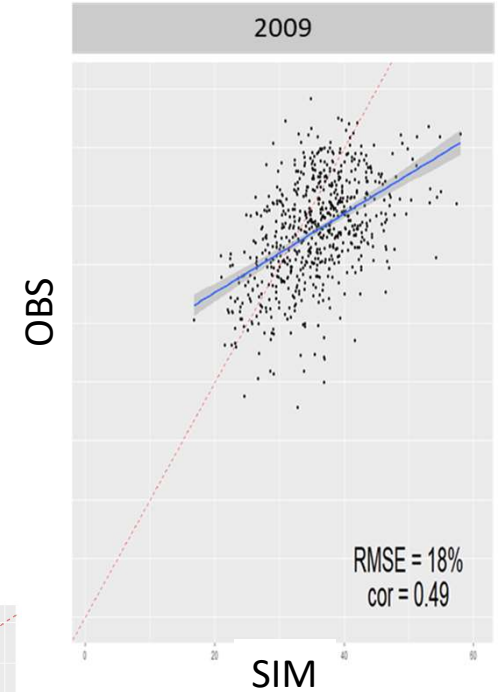With sowing date : 52 %
With soil information : 16 %

11 % of the microplots
(with varietal parameters)

RMSEP= 8.55
correlation = 0.35

observed grain yield
simulated grain yield GY=f(E,G)

imputed soil by euro DB

RMSE = 9.5%
cor = 0.37

SIM
OBS

2009

OBS
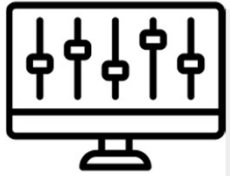SIM

RMSE = 18%
cor = 0.49
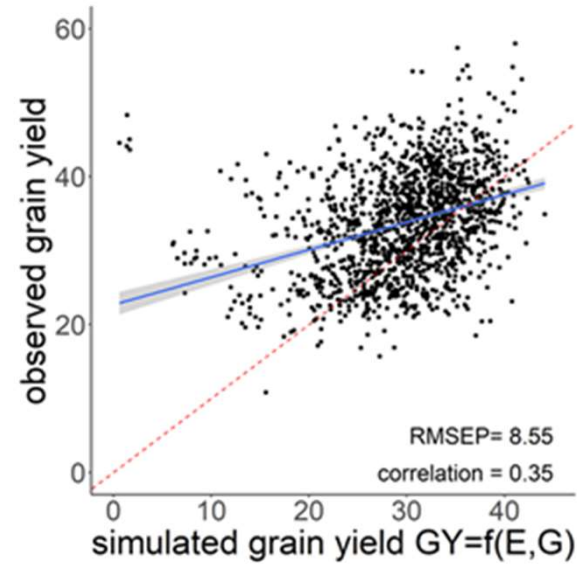
with the best E-M characterization

Oil % prediction
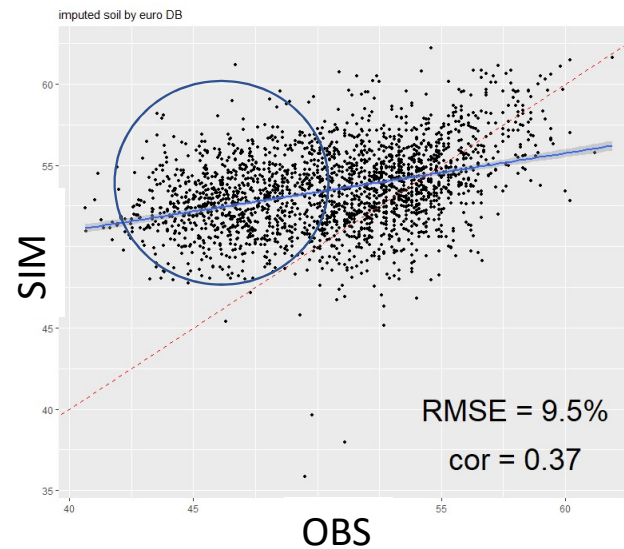
over-estimation
for limiting conditions
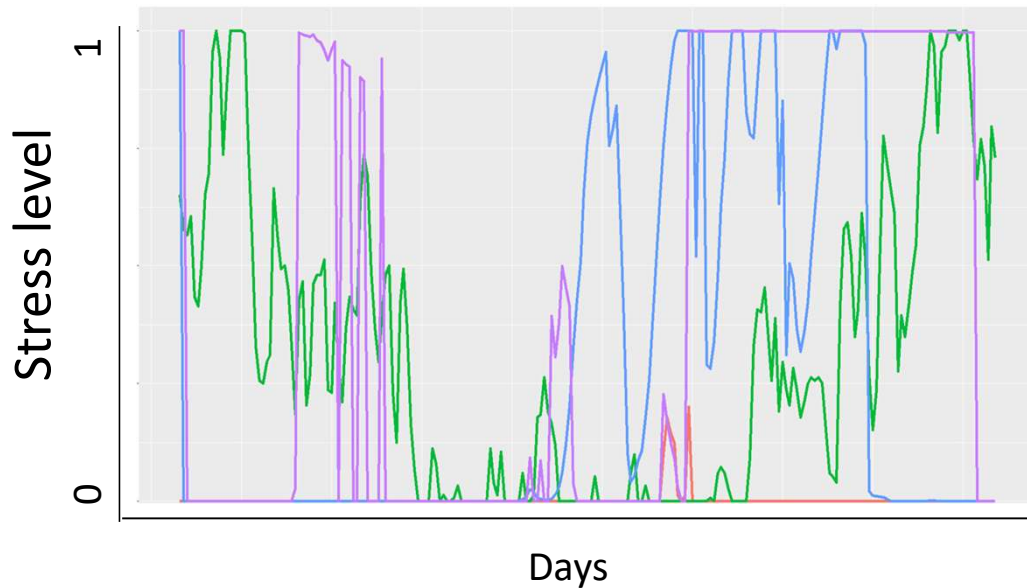
Envirotyping with SUNFLO & clustering

SUNFLO

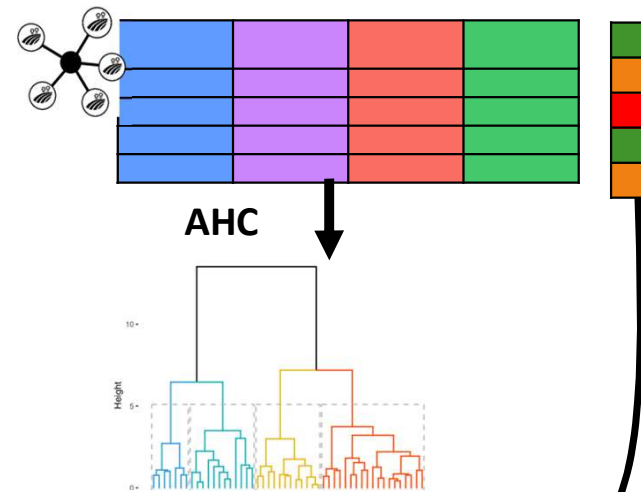- Water stress
- Nitrogen stress
- Heat stress
- Cold stress

Effects on leaf expansion, biomass accumulation & allocation
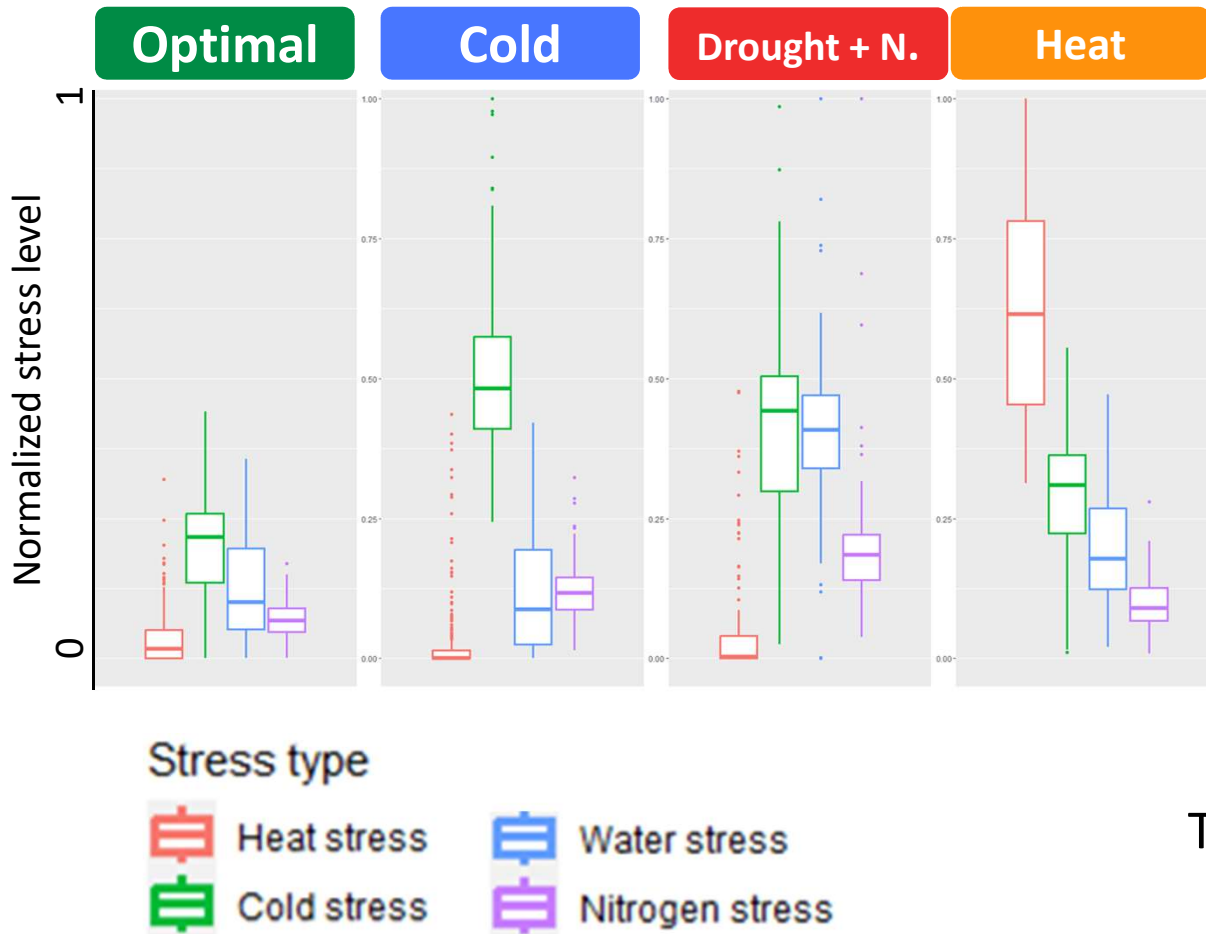
Stress profiles for one simulation

Approach

1. Calculate stress profile
2. Summarize stress profiles
3. Classification of profiles
4. Labelling profile

AHC

4 groups

Identification of Environment Types

- **Optimal :** low abiotic stresses
- **Cold :** high cold stress
- **Drought + nitrogen :** high water & nitrogen stresses
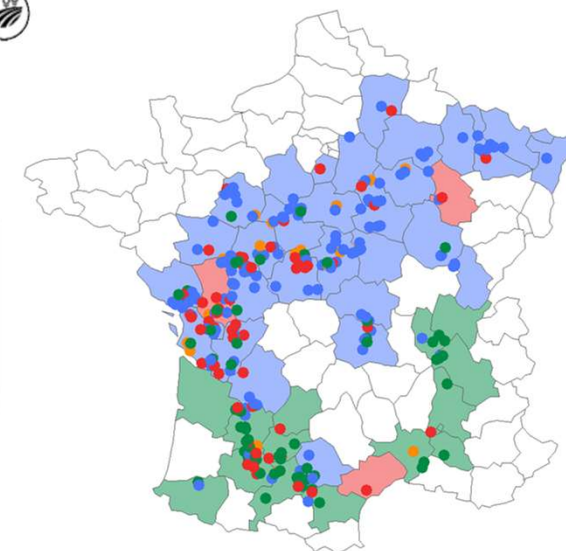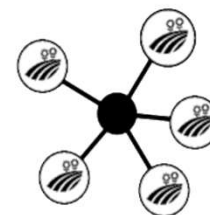- **Heat and drought :** high heat & water stresses

Terres Inovia "crop practices" surveys
Casadebaig *et al.* (2022)

Application to "location x year" situations

Terres Inovia

Optimal 213
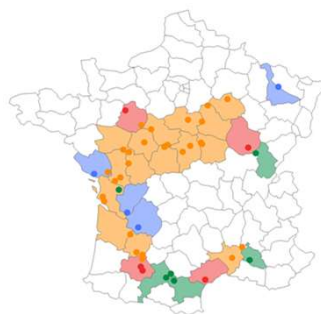**Cold** 319
Drought + N 121
Heat 44
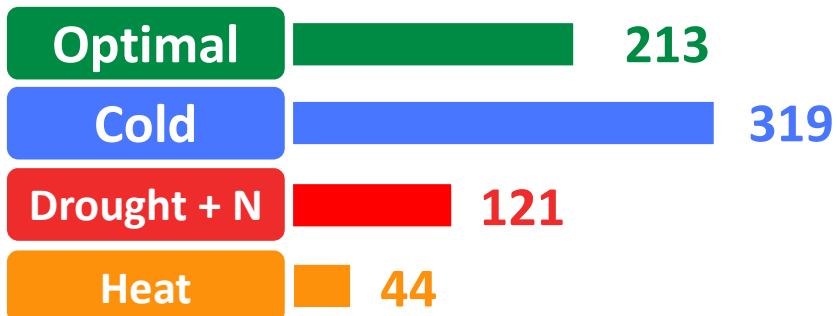
697 labels

location * year

- Identify more homogenous cultivation areas
  + robust categorization (multi-year)
  Implications for variety testing + recommandation
  (*e.g* MET re-design)

- Identify special years *e.g.* 2003
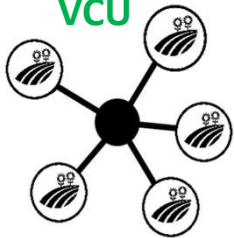 Assessment of the previous growing season

From SUNFLO to a DSS for variety choice

Exposure x sensitivity to biotic factors
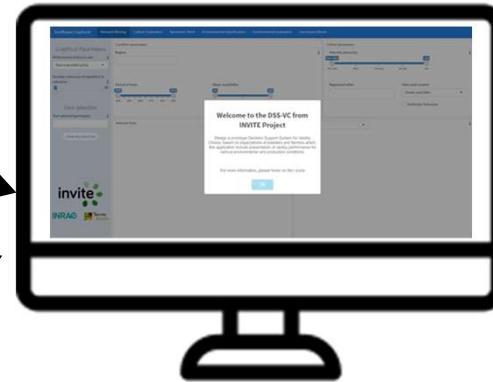
Agronomic merit
Expertise + observed

VCU

Performance
observed

Envirotyping
simulated

E (Soil + Climate)
M (Crop management)
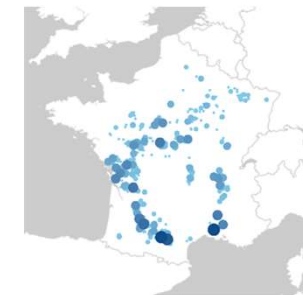G (Genotypic parameters)

SUNFLO

Cultivar Choice
DSS-VC

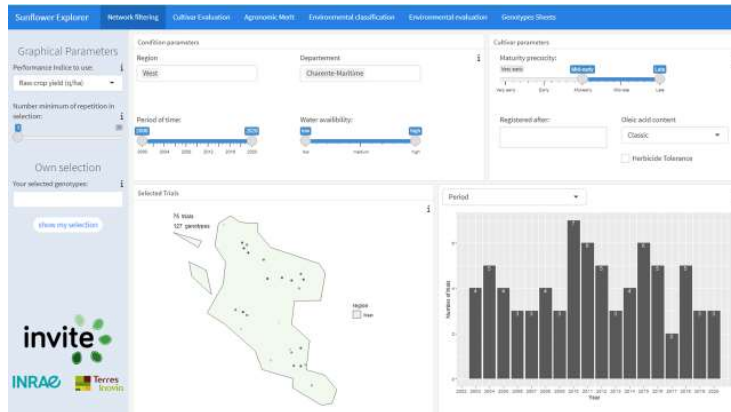**A list of varieties
adapted to a growing
environment**

**Prototype developed
with post-registration
data from France**

METs 2003-2020

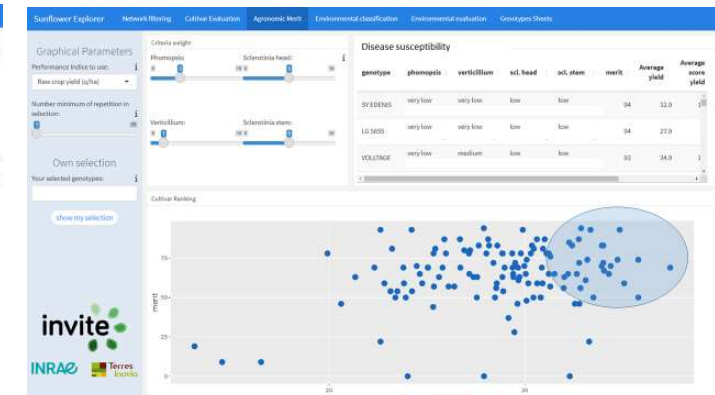# A prototype tool for exploring the VCU results
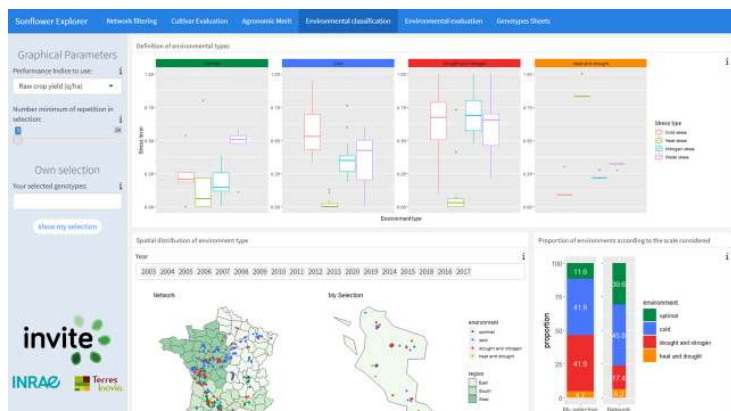
MET description
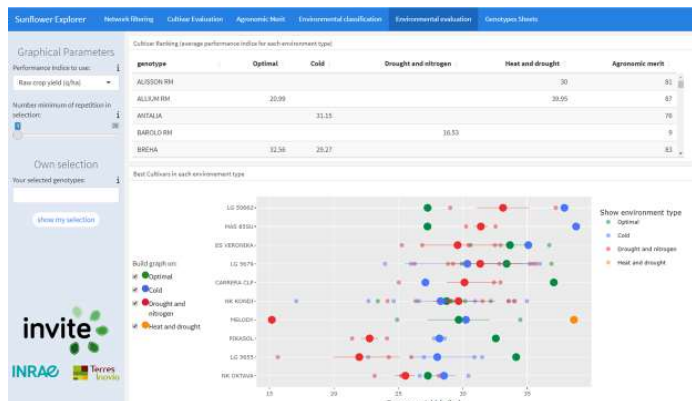

Yield performance

Agronomic merit

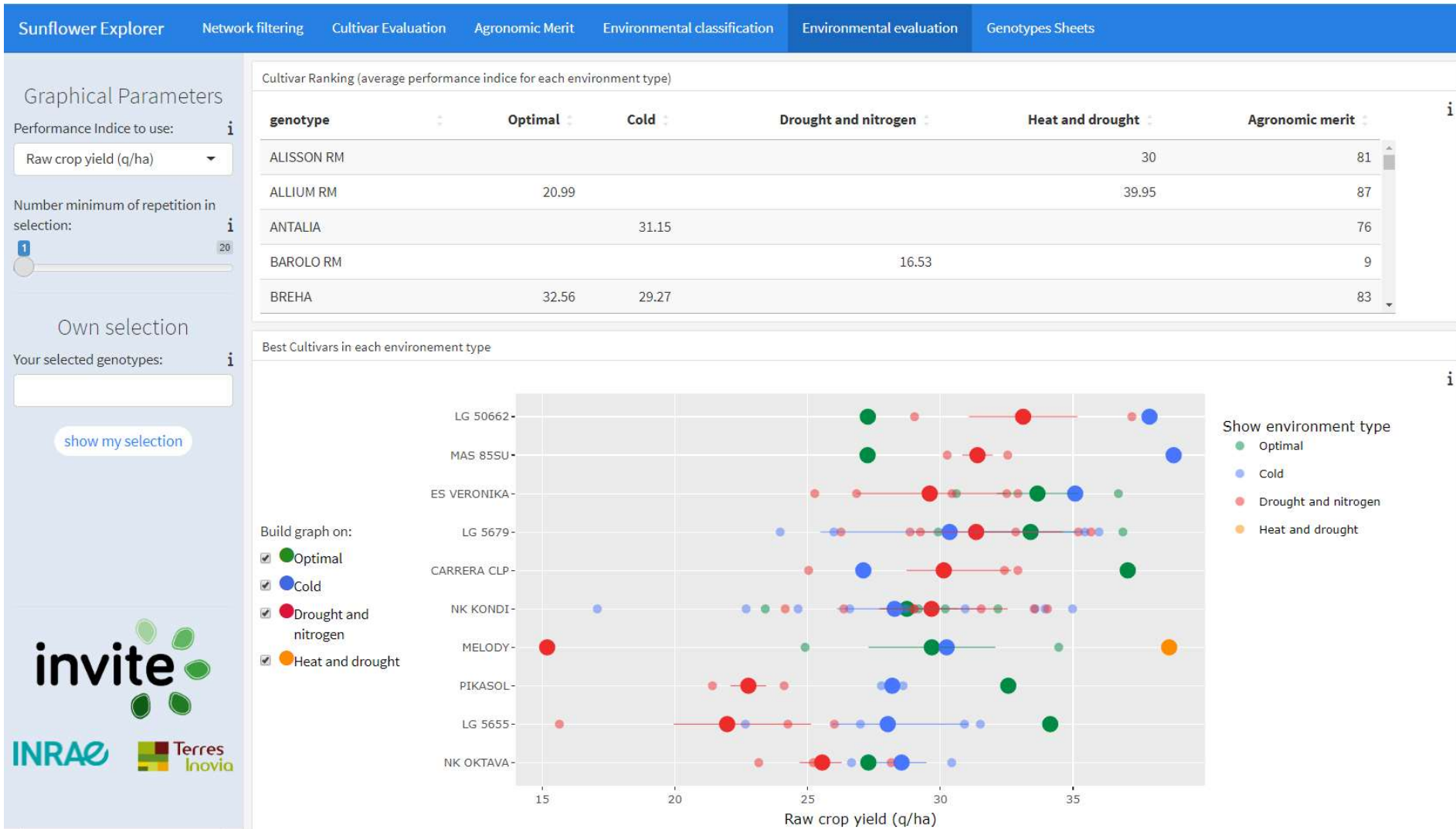## Environment-types (E-T)

Yield as a function of E-T

Variety characteristics

Yield as related to environmental types

Perspectives

- Crop modelling : a relevant tool for characterising growing environments and providing decision-makers with new information for choosing varieties better adapted to their environmental context.

- Some potential areas for improvement : *e.g* the introduction of traits associated to sustainability (e.g canopy closure) that are now tested by examination offices using proxidetection.

- Discussions have been held with varietal evaluation experts in France and Switzerland about the future use of this tool : this will obviously require additional computing developments to couple SUNFLO simulations with their use in the DSS.

- Users should be able to develop their own tools from this prototype, and this DSS could also inspire the development of similar tools for other crops.

Acknowledgements

INnovations
in plant **Var**I**ety** **T**esting
in Europe

Agroscope
75 trials (2006-2020)

AGES
Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH
67 trials (2003-2018)

GEVES
768 trials
(2001-2020)

Terres Inovia
l'agronomie en mouvement
1431 trials
(2003-2020)

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria
36 trials (2014-2018)

nébih
118 trials (2003-2018)

INRAe

Terres Inovia
l'agronomie en mouvement

GEVES