Delivering innovation to growers: how PIA projects have improved information provided to farmers

Symposium inter-PIA 2019

October 17th 2019

Terres Inovia – l'agronomie en mouvement
David GOUACHE
Xavier PINOCHET

ARVALIS – Institut du végétal
Jean-Pierre COHAN

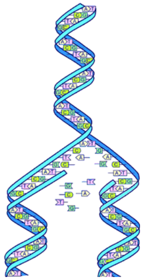
ITB – Institut Technique de la Betterave
Fabienne MAUPAS

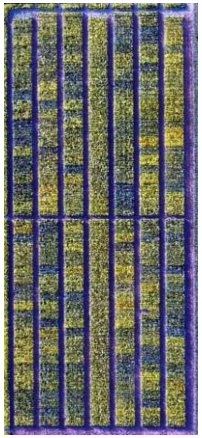
AKER Betterave2020 · PeaMUST · aMaizing · SUNRISE · Breed Wheat · RapsodyN · PHENOME EMPHASIS · ANR · Investissements d'Avenir · GIS BV biotechnologies vertes

Main targets to add value for farmers

High throughput and high definition phenotyping tools

AKER Betterave2020
aMaizing
Breed Wheat
SUNRISE
PHENOME EMPHASIS
RapsodyN
PeaMUST

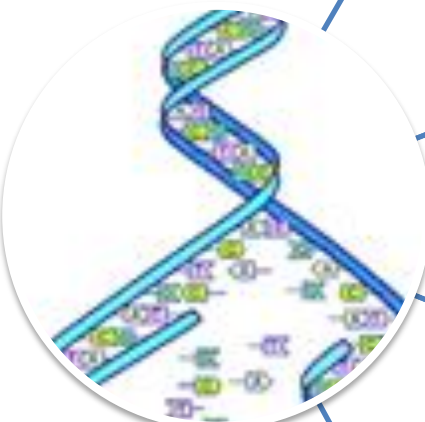




Support of breeding programs

Tools to better characterize & advise registered genotypes

Support of breeding programs



Topics
- Climate changes
- Abiotic stress

GXE interactions
- Real progress
- Post-registration evaluation also concerned

Genetics (Gene & trait discovery, QTL…)
- Real progress
- Lack of sufficiently intense pre-breeding programs to really implement the discoveries in private breeding programs

HTP tools
- Tools available
- Ready to be implemented in breeding programs

Tools to better characterize registered genotypes

GXE interactions

- Real progress
- Nearly in routine use

Cf. Examples

HTP tools

- Tools available
- Adding value to evaluation : in progress

Cf. Examples

Genetisc (Gene discovery, QTL…)

- DNA array and SNP
- Genomic prediction
- Combined use of markers with phenotyping to be addressed

Cf. Examples

GIS bV
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High throughput and high definition phenotyping tools

Platforms

- Ready to be used
- Continuous improvement

Creation of an active community

- Sharing technologies
- Sharing feed-back and use cases
- Spread of technologies to less capital-intensive platforms

Use cases for various purposes

- Direct evaluation of genotype traits
- Models assisted traits evaluation
- Calibration of model-based DSS

Cf. Examples

GIS bV biotechnologies vertes

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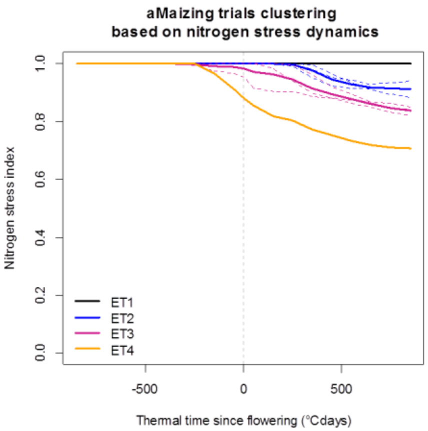
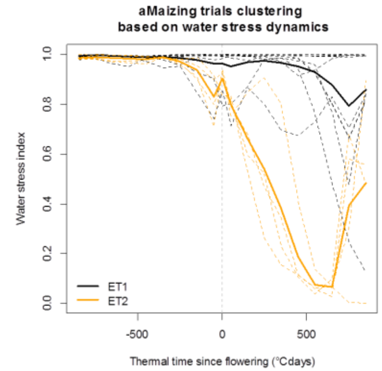
Example 1: characterization of environments in GxE studies



- Four clusters of trials:
  - ET1: no N stress
  - ET2: N stress at SLAG
  - ET3: N stress at flowering
  - ET4: N stress before flowering

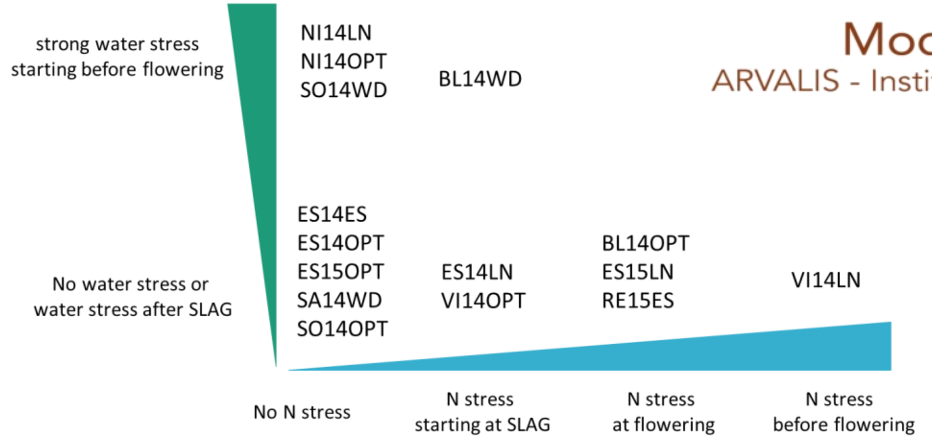
- Clustering explains 13% of the total variance (35% of the trial effect)



- Two clusters of trials:
  - ET1: no water stress or water stress starting at SLAG
  - ET2: strong water stress starting before flowering

- Clustering explains only 2% of the total variance (4% of the trial effect)

Trial name = loc × year × management



Modèle CHN
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Bogard et al. WP5

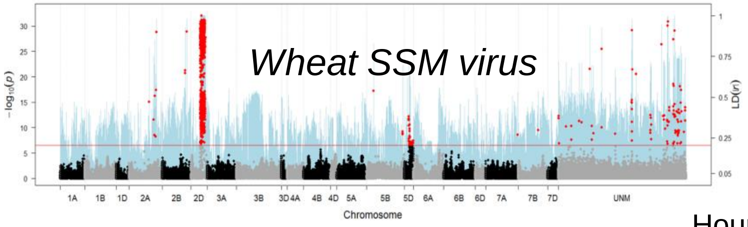
→ Clustering explains 21% of the total variance (55% of the trial effect)

Example 2: DNA array for genomic prediction and functional markers

DNA Arrays (420 K, 35 K)
(BreedWheat WP1)

SNP markers

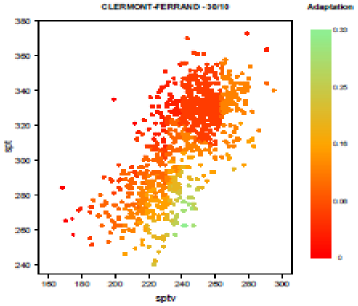
« functionnal QTL » for breeding and cultivar evaluation



Hourcade *et al*., 2018
Plant Pathology

Genomic prediction models

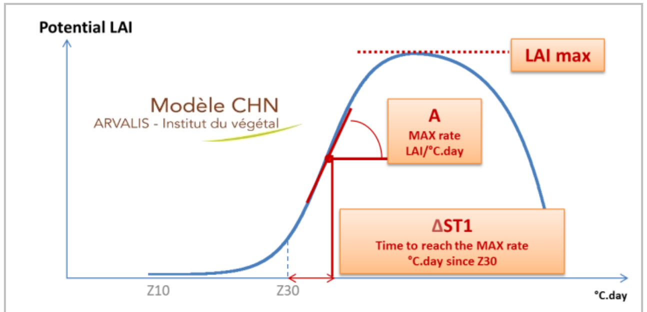
Wheat phenology



Bogard *et al*., in prep

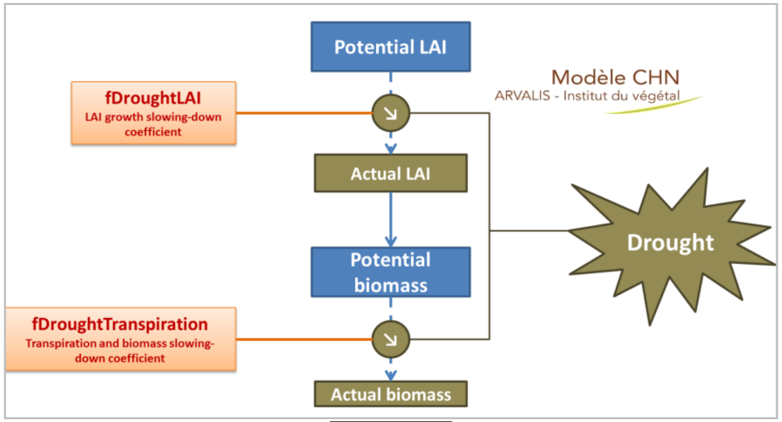
Example 3: Model assisted traits evaluation in wheat

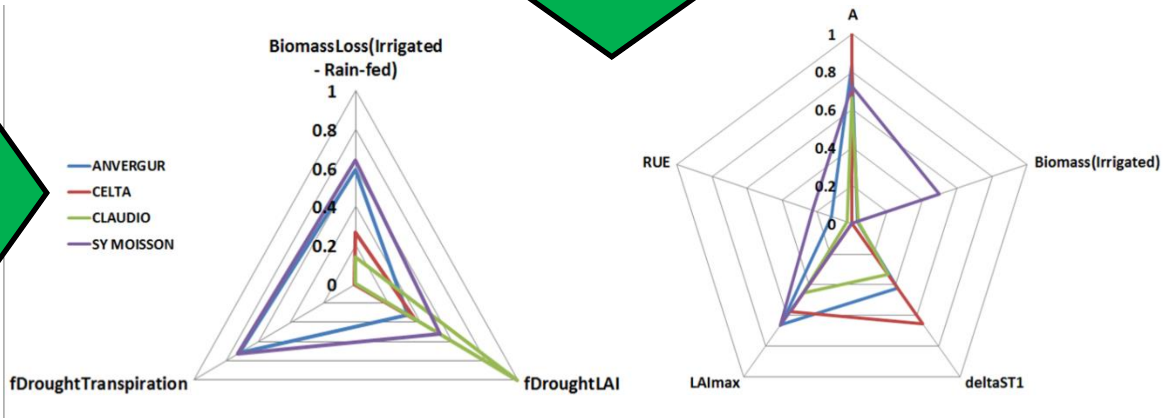
Piquemal *et al.*, 2018 (IPPS)



The potential LAI absorbs **radiation** (MJ/m²).
The absorbed radiation is converted into **potential biomass** (g/m²).

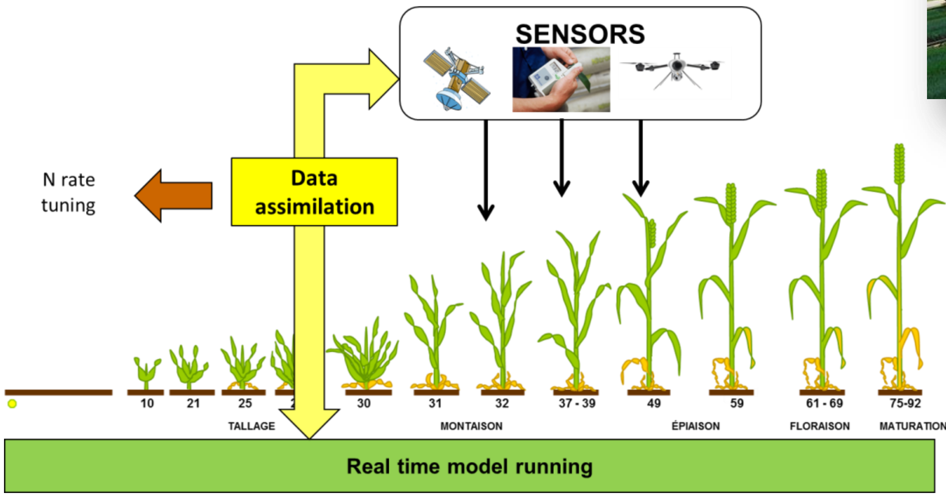
This conversion is controlled by : **RUE** Radiation Use Efficiency g / MJ





Example 4: Use of HTP tools to calibrate model-based DSS

A model is not perfect ➔ need to mix simulation and sensor measurements ➔ more accurate DSS



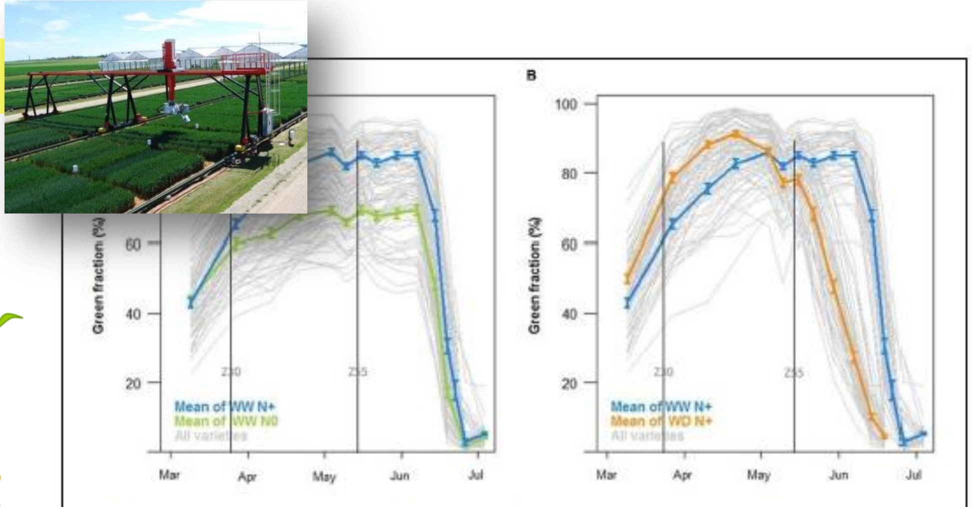


FIGURE 12 | Green fraction (%) during the growing season (A) with the mean of well-watered conditions with nitrogen input (WW N, in blue) against well-watered conditions without nitrogen input (WW N0, in green) and (B) with the mean of well-watered conditions with nitrogen input (WW N, in blue) against water deficient conditions with nitrogen input (WD N+, in orange, N = 44, ±SE) and curves of all varieties (in gray).

Beauchêne et al. 2019- FPS

Modèle CHN
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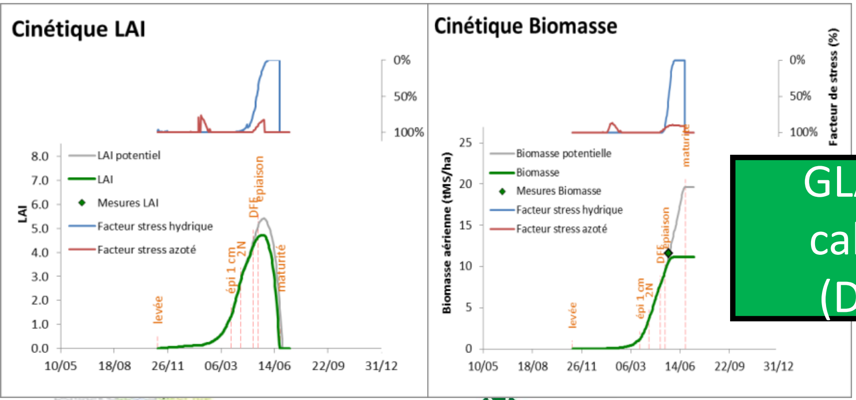
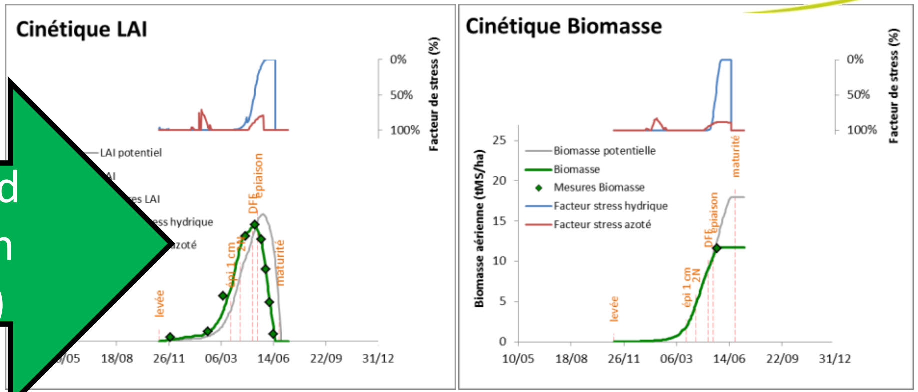
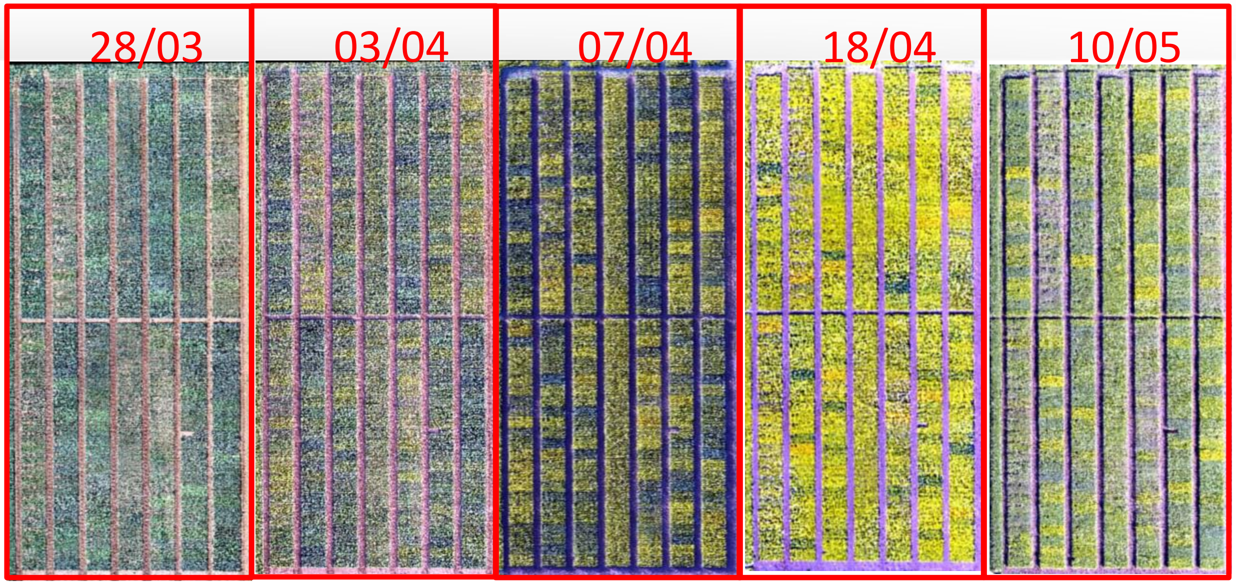


GLAI based calibration (DRM-KF)

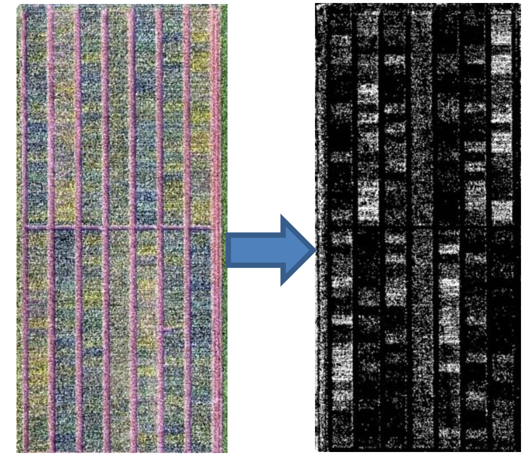


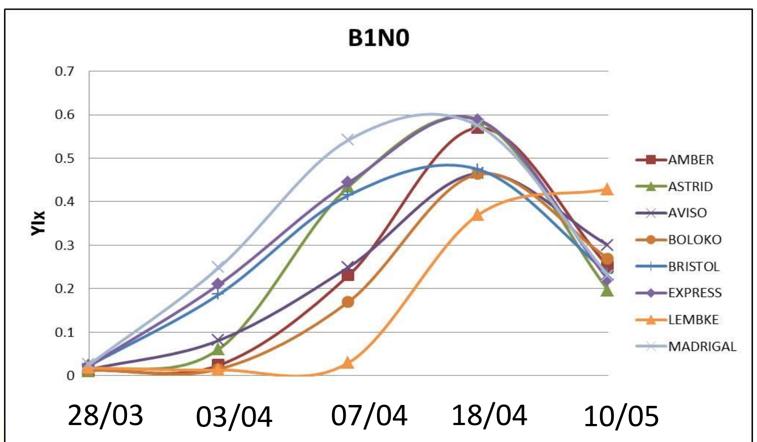
Piquemal et al. unpub.

Example 4bis: Use of drone to assess OSR flowering



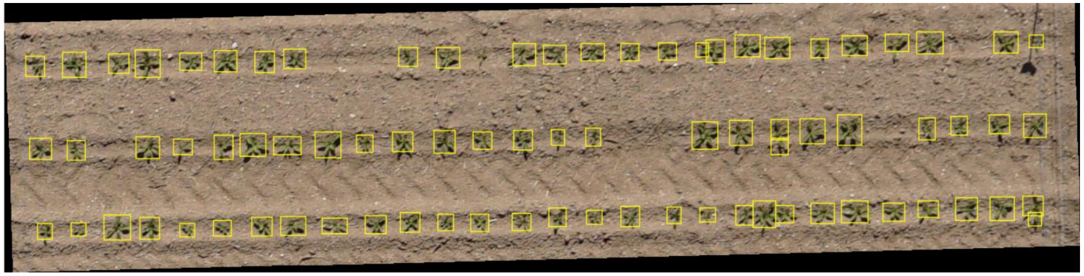
2017





- Rapeseed models : poor phenology models w/ 0 genotypic variability
- Approach → potential for massive data acquisition to calibrate :
  - Breeding/variety trials
  - Remote sensing / big data : Planet satellite constellation

Example 5: Individual sugar beet detection for heterogeneity measurements



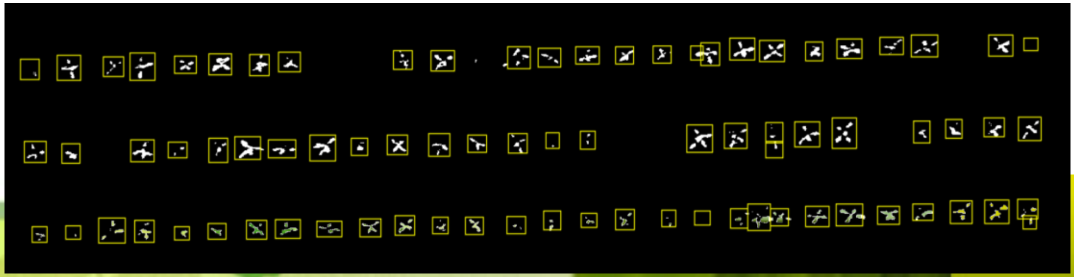
Drone image

<u>1st step :</u>

Beet detection

& green pixels segmentation

Performance : 98%

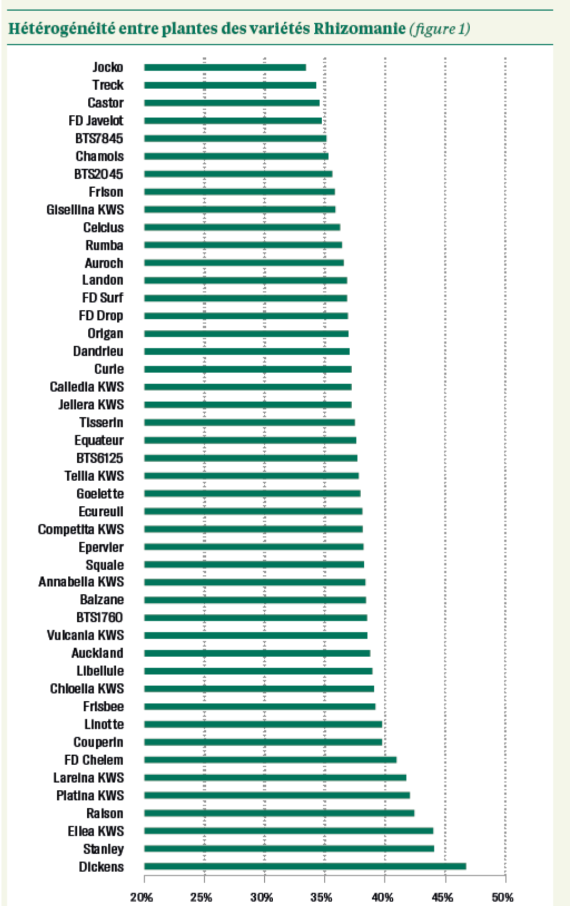


Example 5: Individual sugar beet detection for heterogeneity measurements

<u>2nd step :</u>

Computing coefficient of variation

CV = std / mean for each plot



<u>Choosing a uniform variety</u>

Homogeneous development

➔Simplier harvester set-up

➔Easy weed control

Varietal ranking

→ Advices to growers

Example 6: Use of drone to assess OSR early vigor

Phenotyping for a trait linked to agroecological production

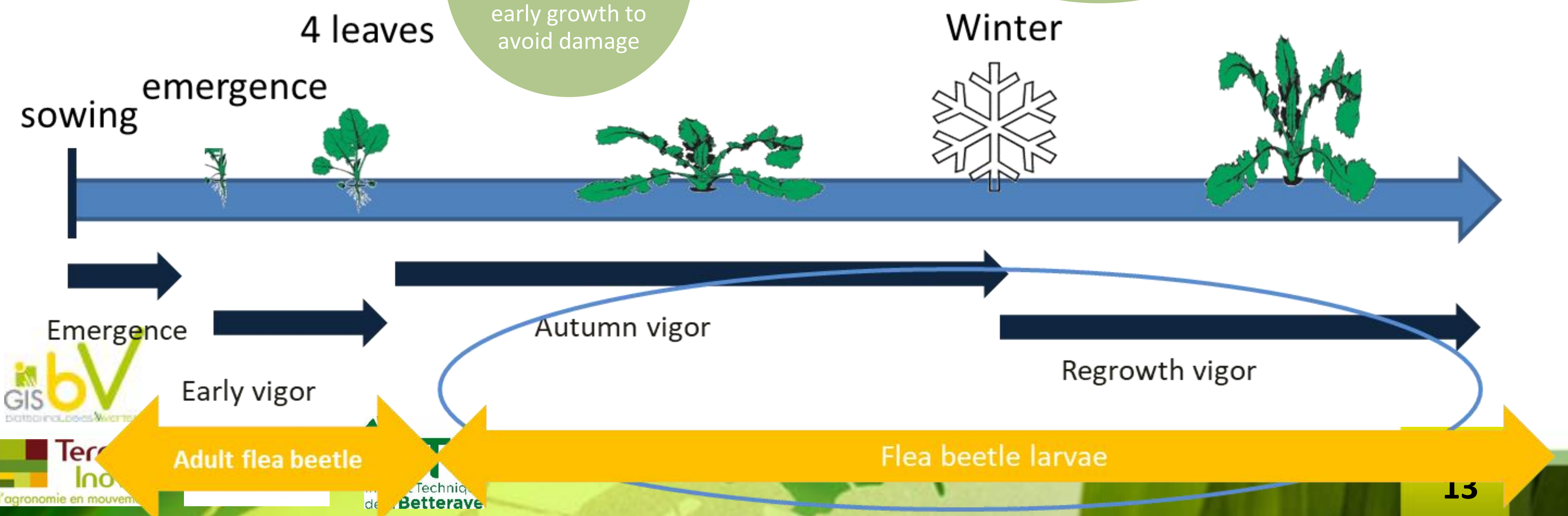
Climate change → august-septembre drought → poor establishment conditions

+

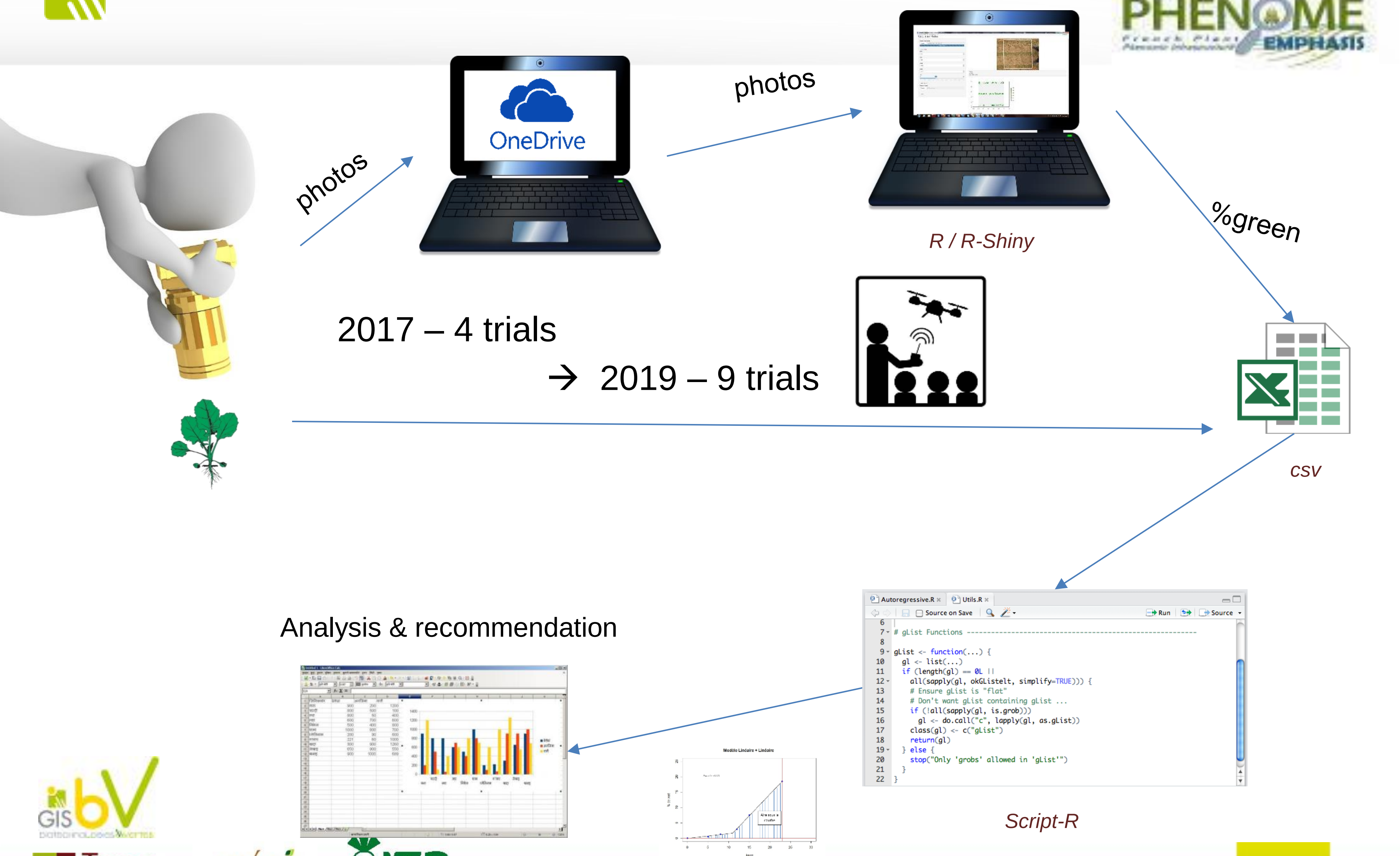
Extension of highly resistant autum insects → need continuous early growth to avoid damage

→

New agronomic paradigm for establishment & early growth to avoid insect(icide)s : towards direct seeding, companion cropping, early fertilization… AND vigorous, continually growing varieties



Example 6: Use of drone to assess OSR early vigor



And now ? ITA priorities to…

Topic	… continue progress in breeding	… continue progress in delivering advice to growers
HTTP tools	Scale up & scale out : democratize tools	
GxE	- Support environmental & agronomic characterization	- Maize example → sunflower, all crops
Trait-QTL-Gene discovery	- Abiotic and biotic stress - Gene editing - Pre-breeding → Largely out of ITA hands (at the moment): are French public & private sector doing what it takes ?	- Pea root rot - Combined use of trials & markers for variety evaluation → new traits & more efficient use of resources
Model-based DSS	- Use in GxE studies	- Sugar beet diseases - Wheat example → rapeseed - Genomic prediction of model parameters

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Thank you for your attention
Thanks to all our colleagues involved in PIA projects !