The use of new technologies in the DUS examination in France - the experience of GEVES

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UPOV Technical Committee (TC/61)
21 October 2025

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Expertise & Performance

Use of biochemical and molecular techniques (BMT) at GEVES in the framework of DUS testing

Main aims are :

Reduce size of DUS trials in the field or in greenhouses, without compromizing quality of the decisions

By sorting more efficiently varieties from the variety collection to be put in the DUS trials = UPOV « model » : Combining Phenotypic and Molecular Distances in the Management of Variety Collections

By reducing the number of identity controls in the field/greenhouses

Ensuring the reliability of trials and decisions

reliable choice of reference varieties

identity checkings

Optimize activity timeline in our laboratories (biotests vs. Marker tests)

by using and developing UPOV « model » : Characteristic-Specific Molecular Markers

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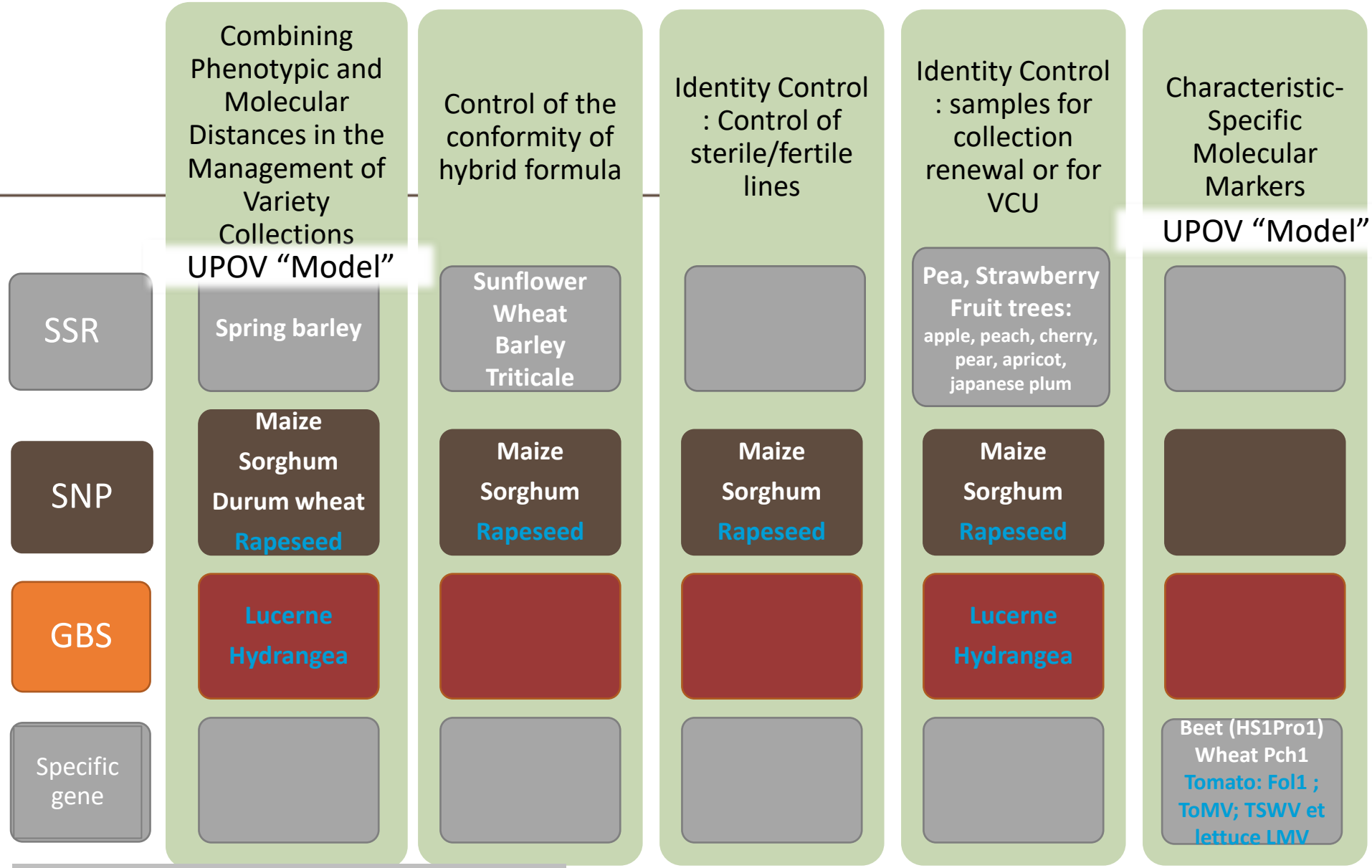
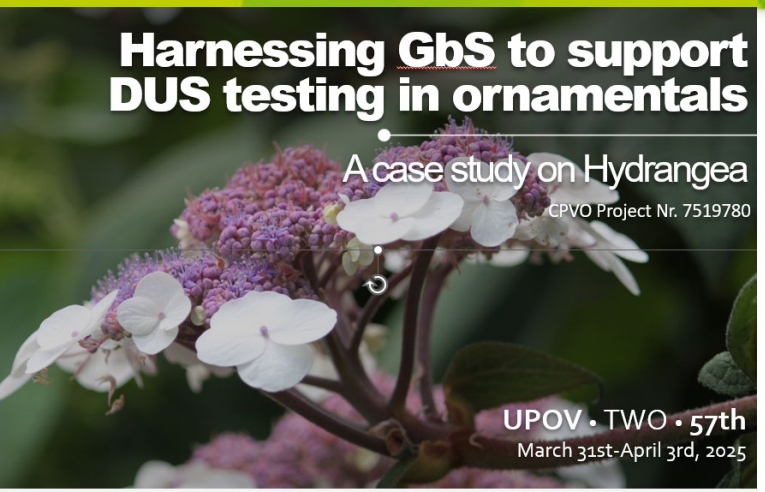
Overview of the current uses and developments at GEVES



Species in white: utilization in routine
Species in blue : development phase

⇒Molecular markers are used in the framework of DUS testing for 10 to 15% of species studied in GEVES

Use of BMT at GEVES in the framework of DUS testing



Focus project: "Harnessing molecular data to support DUS testing in ornamentals: a case-study on Hydrangea"

Two main objectives

1. To genotype the French national reference collection of Hydrangeas, an *in vivo* collection of over 1,100 accessions maintained at the Gaston-Allard Arboretum in Angers

An innovative approach:

* Using **high-throughput sequencing technologies** to identify, screen and select a genome-wide panel of SNP markers
* **Combining 'neutral' genetic markers and markers** linked to ornamental traits to characterize varieties in collection

2. To design an optimal approach to integrate molecular analyses in routine DUS examinations of Hydrangeas

with the purpose of **(1) securing DUS tests** and **(2) guiding the selection of reference varieties** to optimize examinations

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Harnessing GbS to support DUS testing in ornamentals

Summary

* This project demonstrated the cost-effectiveness of opting for **high-throughput sequencing** for describing entire reference collections all in one go
* It may pave the way for similar projects to support DUS testing in other ornamental species for which genomic resources are not available or for which maintaining a living collection is not possible or costly

Main deliverables

✓ **7,410 SNPs** in total were identified

H. aspera	475
H. arborescens	421
H. macrophylla	**5,649**
H. paniculata	617
H. quercifolia	285
H. serrata	5,528

✓ A **set of 20 SNPs** was selected for confirming species identity and checking the pedigree of declared hybrid candidate varieties

✓ A **set of 40 SNPs** was selected for varietal identification in *H. macrophylla*

✓ **Several SNPs were identified as interesting candidates to explore correlations between genotype and phenotype *but* work is still required to test advanced modelling approaches** such as approximate conditional phenotype analysis based on GWAS statistics

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Use of BMT at GEVES in the framework of DUS testing, and perspectives

- Validated UPOV models , used in routine at GEVES
- Proven efficient to reduce size of field DUS trials in case of model « Combining Phenotypic and Molecular Distances in the Management of Variety Collections”
- Opportunities to developp same approaches to other crops
- Opportunities and Challenges to develop “shared molecular databases”
  - specific guidance for the setting and the maintenance of common European molecular databases to be drafted by experts under the coordination of the CPVO
  - Access to Authorities and Offices; breeders to be informed
- Confidentiality Issues

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Use of digital image analysis at GEVES in the framework of DUS testing

Why implementing digital phenotyping in DUS testing?

-To replace visual observations or manual measurements

-To get more accurate measurements, greater precision

-To increase reliability of assessments

by reducing subjectivity linked to the human observation, and reducing observer effect

-To save time

by replacing labor-intensive measurements with single analysis

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What is in development or under test for phenotyping

Example on characteristic « Plant : height » with UAV or stick

- Feasible only if « natural height » is mainly considered (nevertheless other traits under development)
- On maize and sunflower for the moment (see example below on VCUS 2022 sunflower trial)

Use of DJI MAVIC 2 PRO UAV with a network of GCPs in the field and Aether by Alteia© platform for analysis

- At INRAE UMR IGEPP : test of a homemade stick for height measurement

(based on ultrasound sensor)

=> in partnership with GEVES, needs to be improved

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What is in development or under test for phenotyping

Example on characteristic « Plant : height » with UAV on lucerne

➢ **Materials :**

- **DUS trial :**
  - Semis : 2023
  - Mesures faire en A2

- **UAV model :**
  - DJI Mavic 3M
  - Analysis on Aether by Alteia platform

➢ **Methods :**

Use of DJI MAVIC 3M UAV without GCPs and Aether by Alteia© platform for analysis

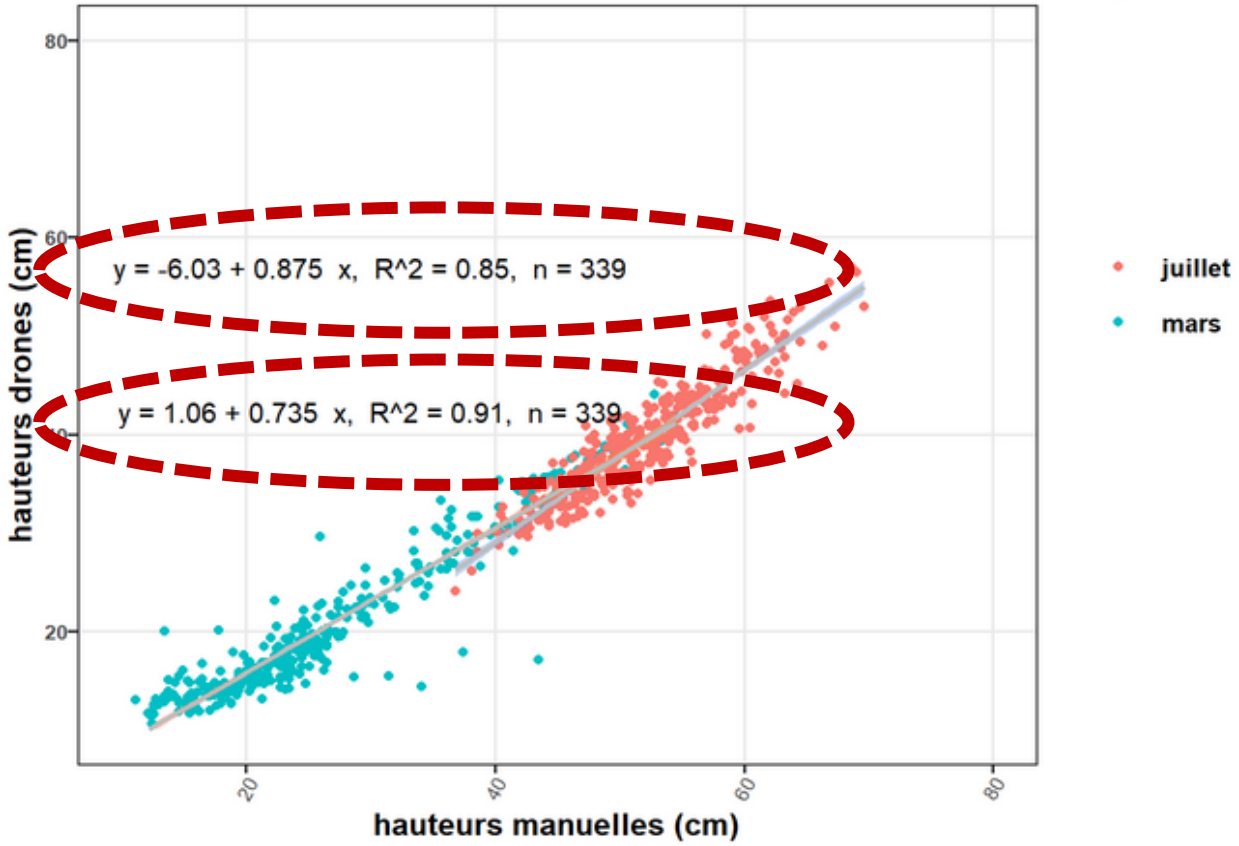
- **Manual measurement**
  - With DUS protocol (6 measurements / plot)
  - Increasing of measurement points (up to 18 by plot)

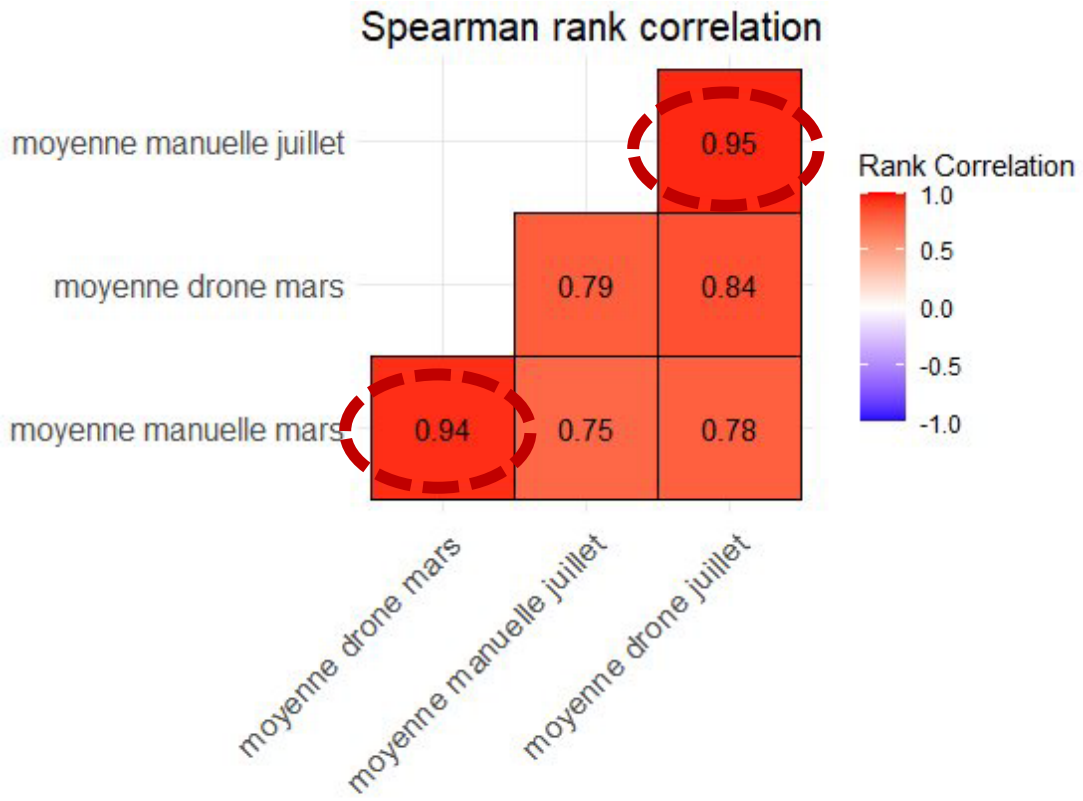
- **With UAV:**
  - Measurement from bare soil
  - Measurement with 10cm threshold

- **2 dates of measurements:**
  - **march 2024, 15th**
  - **july 2024, 4th**

What is in development or under test for phenotyping

Example on characteristic « Plant : height » with UAV on lucerne



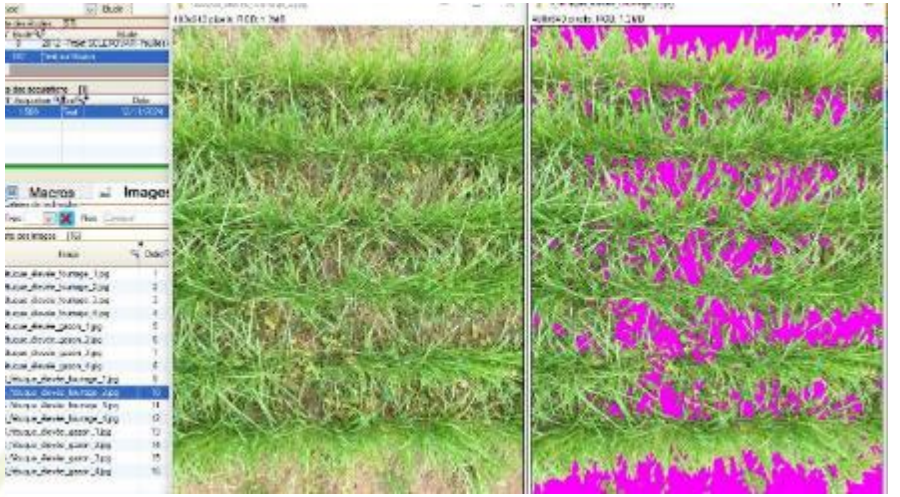


"Good" correlation by manual and UAV measurements + variety ranking is the same with both methods

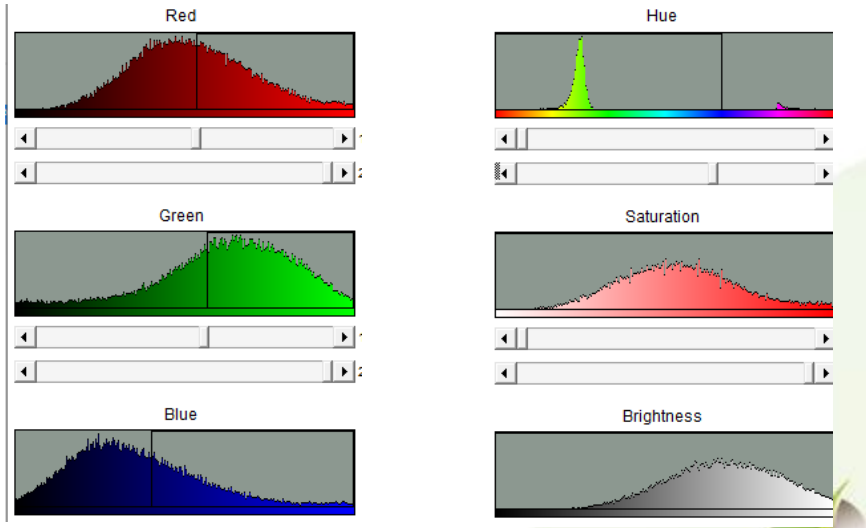
What is in development or under test for phenotyping

Example on characteristic « Leaf: intensity of green colour during vegetative growth stage » with stick on fescue

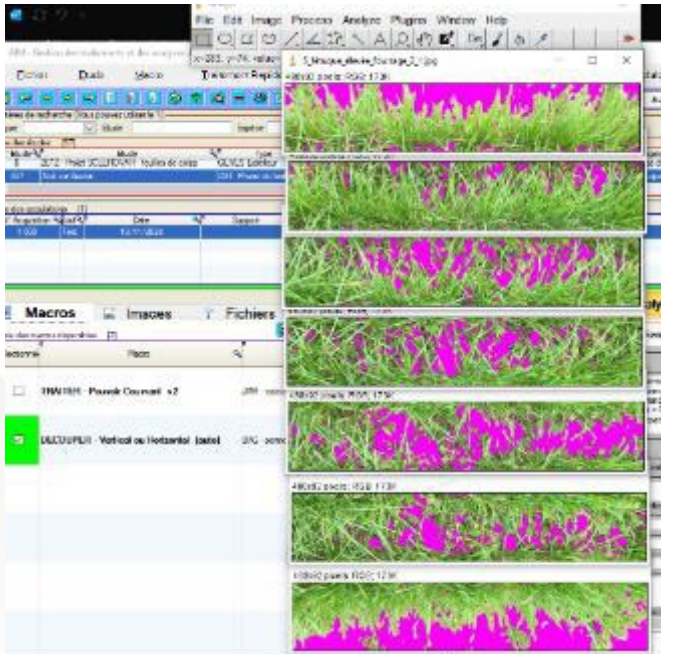
- Steps:
  - Picture acquisition in the field by LITERAL stick
  - Image analysis by ImageJ macro
  - Ranking by DUS software



2- Swith of colorimetric space from RGB –> HSB in order to perform a better "green" quantification



1- from raw picture -> vegetation segmentation + image cutting with 24 thumbnails



min	max	note
jaune	Jaune +	1
Jaune +	Vert-jaune -	2
Vert-jaune -	Vert-jaune	3
Vert-jaune	Vert-jaune +	4
Vert-jaune +	Vert -	5
Vert -	vert	6
vert	Vert +	7
Vert +	Vert-cyan -	8
Vert-cyan -	Vert-cyan	9

3- converting to notes from 1 to 9

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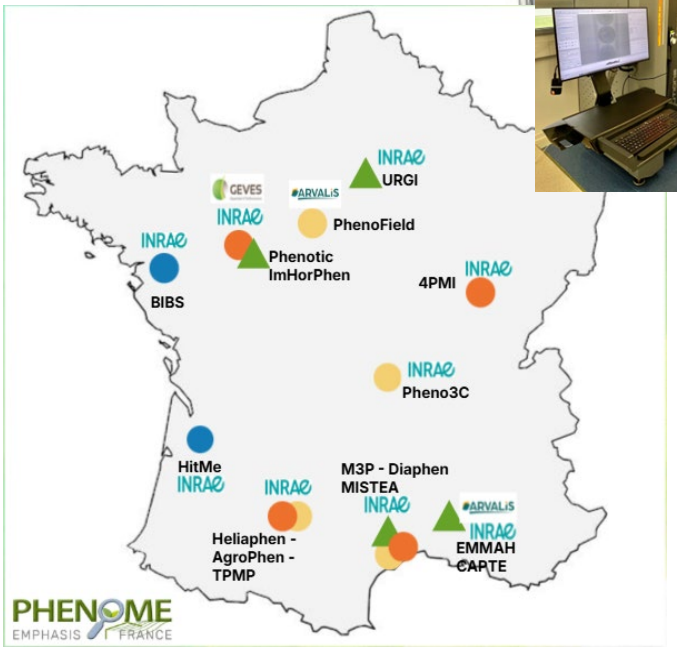
GEVES: member of PHENOME, the French Phenotyping Infrastructure

11 distributed platforms and 2 R&D teams

« Characterisation »
2 biochemical phenotyping platforms

« Evaluation »
4 Field platforms

« Understanding »
4 controled conditions



Data services

Image workflows services

- ~ 75 ETP dont ~50 INRAE

+ enlargement to other field platforms : lean field phenotyping

Example Agroecophen project
16 experimental units including
3 GEVES units

Field
Controled cond.

Analytics
Methodological projects

Link to European infrastructure for Plant phenotyping

Use of digital image analysis at GEVES in the framework of DUS testing, and perspectives

- 2-D Image analysis is used in routine, with good results for DUS : but very simple approach
- GEVES interested in 3-D images ; Lean field phenotyping with drones, connected sticks, smartphones : under test or under development
- Constraints of DUS : meet the technical requirements + cost effectiveness
- Need to mutualize efforts – with Scientists – with other Members
- Will artificial intelligence revolutionize our DUS work?

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Thank you

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