Phenotyping for breeding and pre-breeding

OCTOBER 7, 2025 I ROLAND PIERUSCHKA

IBG-2 – FORSCHUNGSZENTRUM JÜLICH GMBH

PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

2nd International Workshop on Plant Genetic Resources

JÜLICH Forschungszentrum

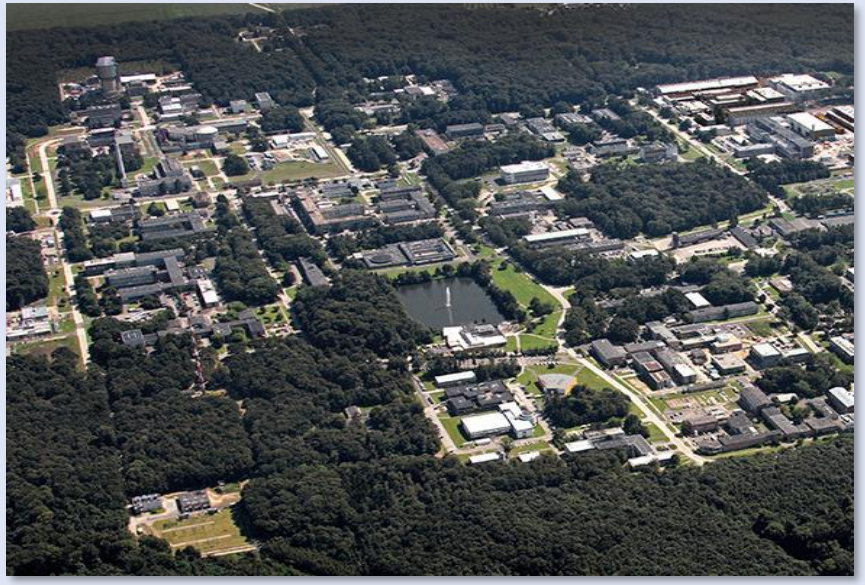
FORSCHUNGSZENTRUM JÜLICH (JÜLICH RESEARCH CENTER)

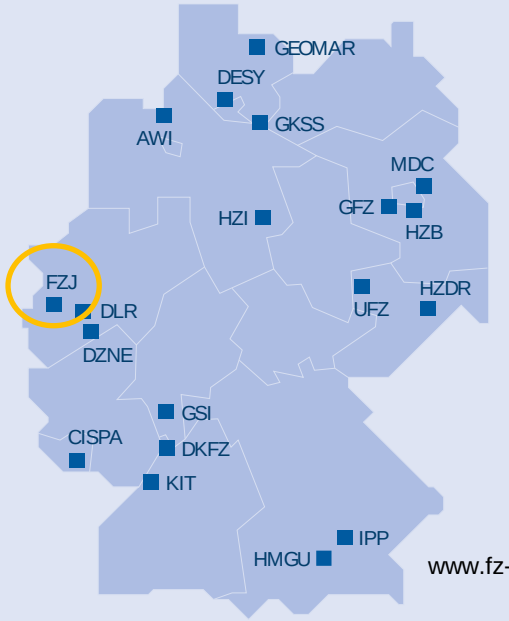
HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

11
INSTITUTES

~850
Mil euros **REVENUE**
(45 % external funding)

~7000
EMPLOYEES





www.fz-juelich.de

INSTITUTE FOR BIO- AND GEOSCIENCES

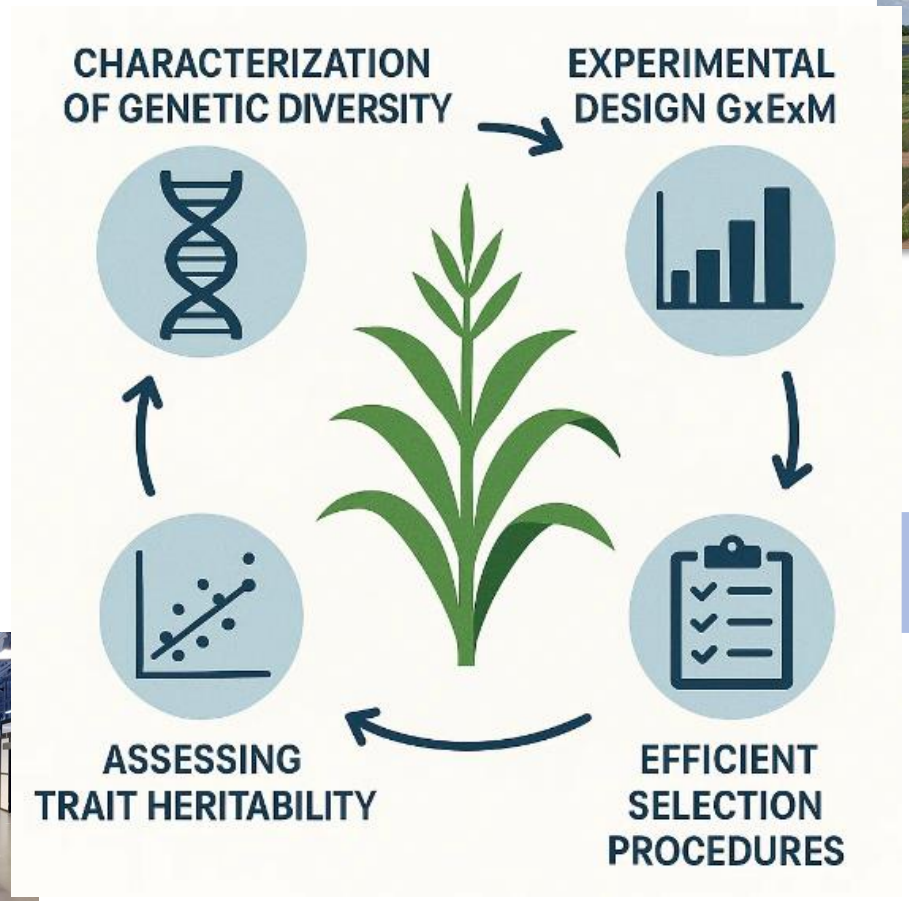
FUTURE FIELD
BIOECONOMY

- Biotechnology
- Plant Sciences and Phenotyping
- Agricultural production systems
- Bioinformatics and Structural biology

IMPROVING CROP VARIETIES: VALUE OF PHENOTYPING FOR PLANT BREEDING PROGRAMMES

Introducing and maintaining beneficial genetic diversity are at the core of prebreeding

- Use of new genetic resources
- Broaden the genetic base of crops



- Sustainable food production systems
- Efficient/productive crop varieties

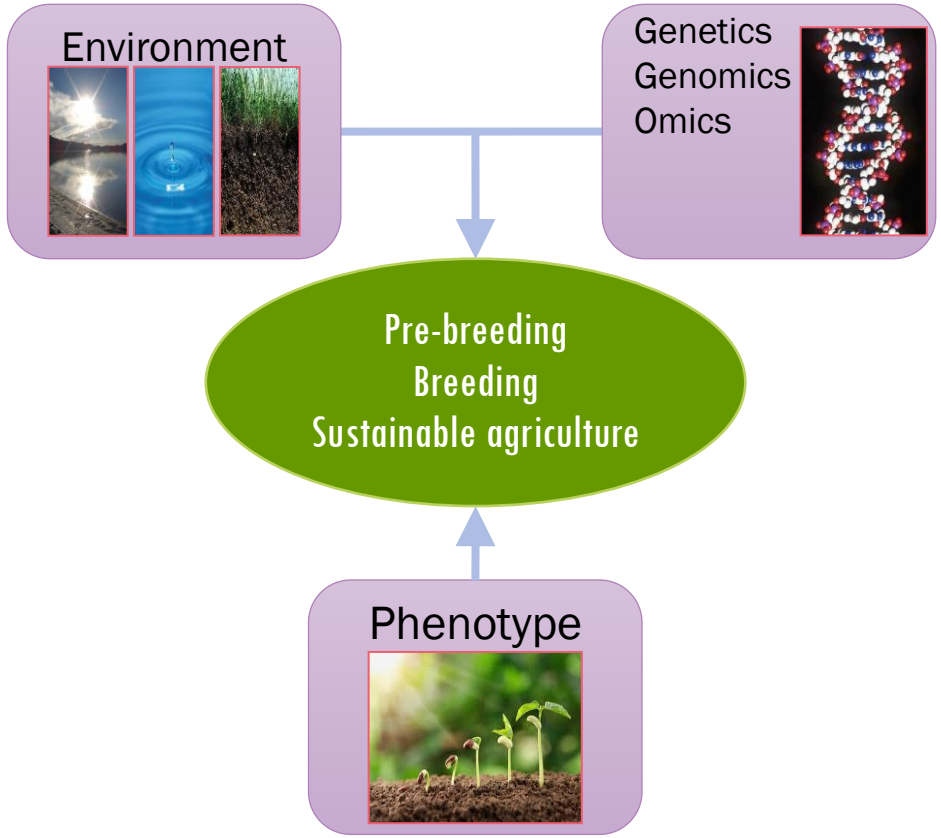
De Paola et al 2025 Annals of Botany
Watt et al 2020 Annual Review of Plant Biology

EXCHANGE BETWEEN PRO-GRACE AND EMPHASIS

PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

EMPHASIS

Joint policy symposium and workshop about plant genetic resources and phenotyping



Key elements addressing synergies between GRACE-RI and EMPHASIS

→ Exploit PGRs for sustainable agriculture

- **Seed phenotyping**
- **Cost-effective phenotyping**
- **Data management**

From Véronique Lefebvre and Ignazio Verde modified

EXCHANGE BETWEEN PRO-GRACE AND EMPHASIS

- Wide range facilities, sensors etc.
  - no one fits all solution
  - harmonisation is essential
  - costs are decreasing
- Most cost effective experiments are those in databases
- Interaction - reduce parallel developments

ELSEVIER
Plant Science
Volume 282, May 2019, Pages 14-22

What is cost-efficient phenotyping? Optimizing costs for different scenarios ☆

Jahnke et al 2016
Müller-Linow et al 2023
De Paola et al 2025

INTEGRATION PIPELINE AT IBG2

Seed-to-Plant Life Cylcle

Seeds

Seedling Establishment

Vegetative growth

Yield & harvested product

Performance in fields

« Controlled » conditions ⟷ « intense lean Field » conditions

VECTORS / SENSORS / IMAGE ANALYSIS SERVICES

DATA SERVICES

« Understand » ⟷ « Evaluate » ⟷ « Implement »

EMPHASIS

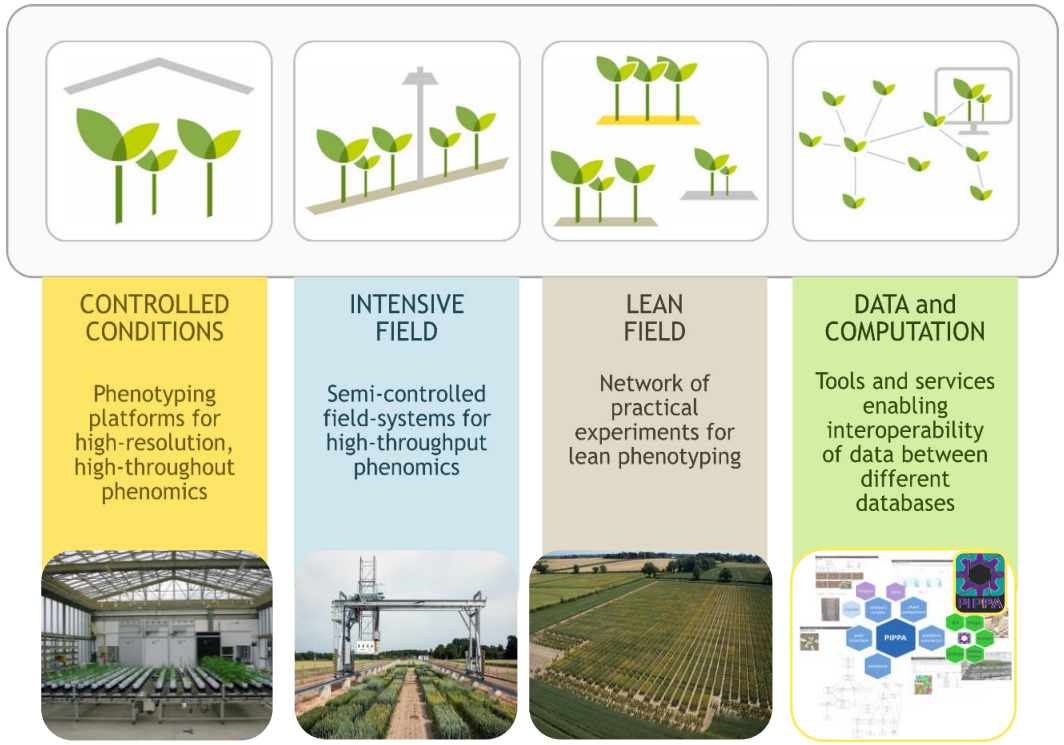
Deutsches Pflanzen Phänotypisierungs-Netzwerk DPPN

INTEGRATION ACROSS EUROPE

EMPHASIS

Mission

Facilitate multi-scale plant phenotyping to analyse genotype performance in diverse environments and to quantify crop traits to promote future food security in a changing climate.

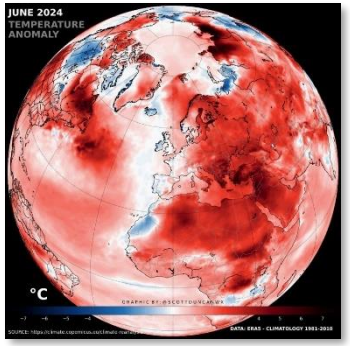


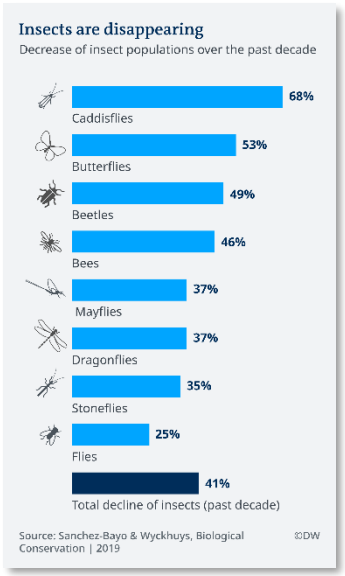
Coordinated from within Belgium/VIB

VIB
science meets life

From EMPHASIS

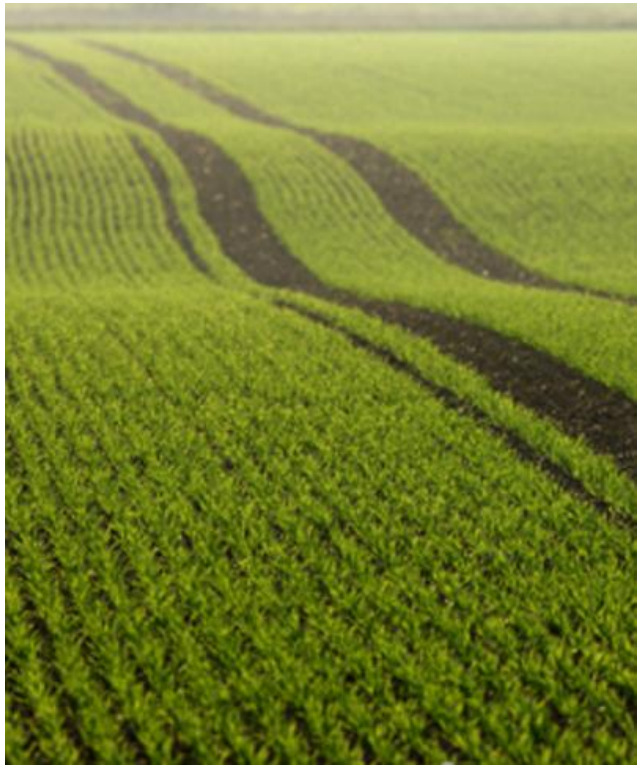
THE CURRENT THREATS …AND THE BIG CHALLENGES





DATA ⟷ (predictive) MODELS

Genotype x **E**nvironment



⇒ **Food insecurity**
⇒ **Health dammage**
⇒ **Endangered agricultural sector**

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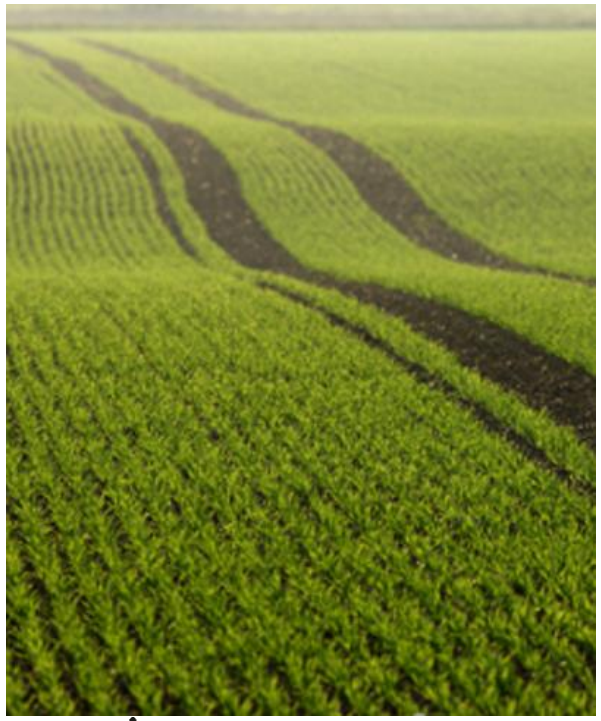
…AND THE BIG CHALLENGES

Currently dominant agricultural practices



- **biotic interactions**
- **innovative practices**
- **future genotypes**

DATA ⇄ (predictive) MODELS

Genotype x **E**nvironment x **M**anagement x **S**pecies

New breeding targets
Demand for genetic resources

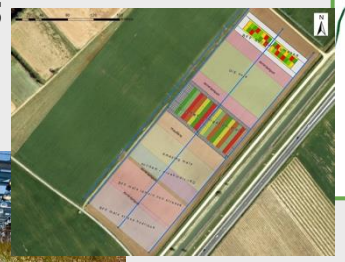
Agroecology-based agroecosystems

PHENET
PHENOTYPING & ENVIROTYPING SOLUTIONS FOR AGROECOLOGY

PLANT PHENOMICS USE CASE

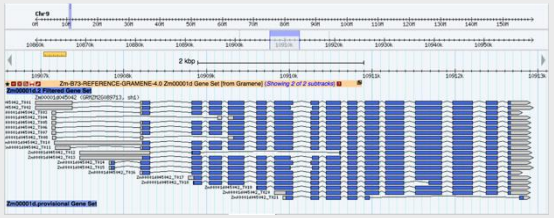
Environment / Phenome / Genomic / *omic / Genetic

Phenomics



Findable Accessible Interoperable Reusable

Genetics
Genomics
Omics



Plant Breeding /Prebreeding
Genetic variations by Traits

Climate Change Studie
Genotype X Environment

Dispersed
Heterogenous
Getting Standardized

Mostly centralized
Homogenous data
Heterogenous metadata

Findable Accessible Interoperable Reusable

Environment

Dispersed
Heterogenous

From Cyril Pommier - modified

DATA STANDARDS FOR FAIR

Semantic

- Description of the data
- Controlled vocabularies: term name and definitions
- Ontologies: semantic links bet terms
- *Biologist* driven

The Sequer

Persistent Unique Identifiers
URI, gene ID, accessions ID, Trait ID, DOI,…

Structure

- Formatting and Organizing the data
- Data Models
- Standards : CSV, VCF, GFF, MIAPPE (www.miappe.org) , etc…

Biologist & Computer scientist driven

miappe

echnical

- Data integration and sharing
- Interoperability : tools and systems
  - Breeding API www.brapi.org
  - Computer scientist driven

BrAPI

EMPHASIS

elixir

Trends in Plant Science

CellPress

30th Anniversary issue: Big concepts – shaping the future of plant science

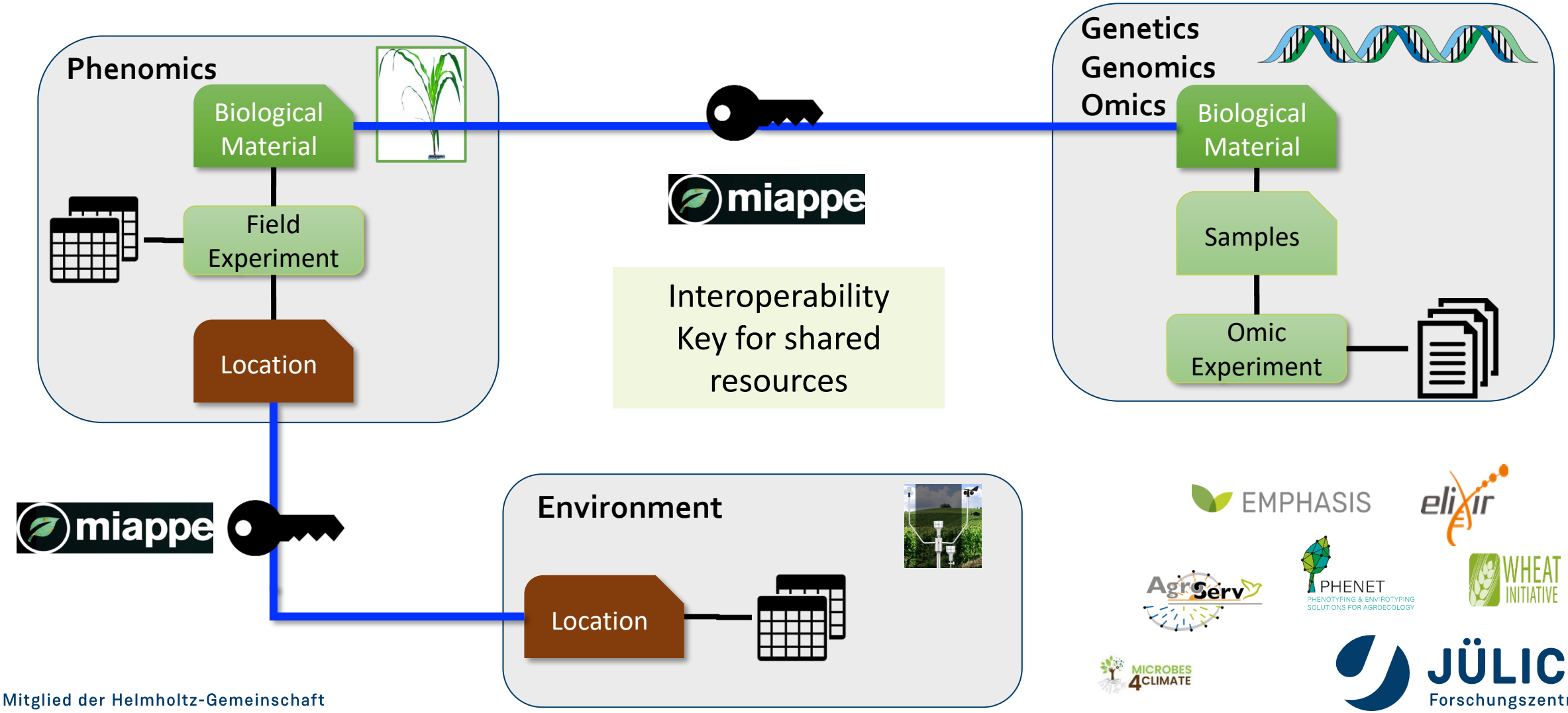
Opinion

Reassessing data management in increasingly complex phenotypic datasets

Cyril Pommier[1,*], Isabelle Alic[2], Llorenç Cabrera-Bosquet[3], Xavier Draye[4], Pascal Neveu[2], Jochen C. Reif[5], Kelly R. Robbins[6], Pawel Krajewski[7], and François Tardieu[3,*]

From Cyril Pommier - modified

DATA INTEGRATION BETWEEN SILOS



EMPHASIS
elixir
AgroServ
PHENET
PHENOTYPING & ENVIROTYPING SOLUTIONS FOR AGROECOLOGY
WHEAT INITIATIVE
MICROBES 4CLIMATE
JÜLICH Forschungszentrum

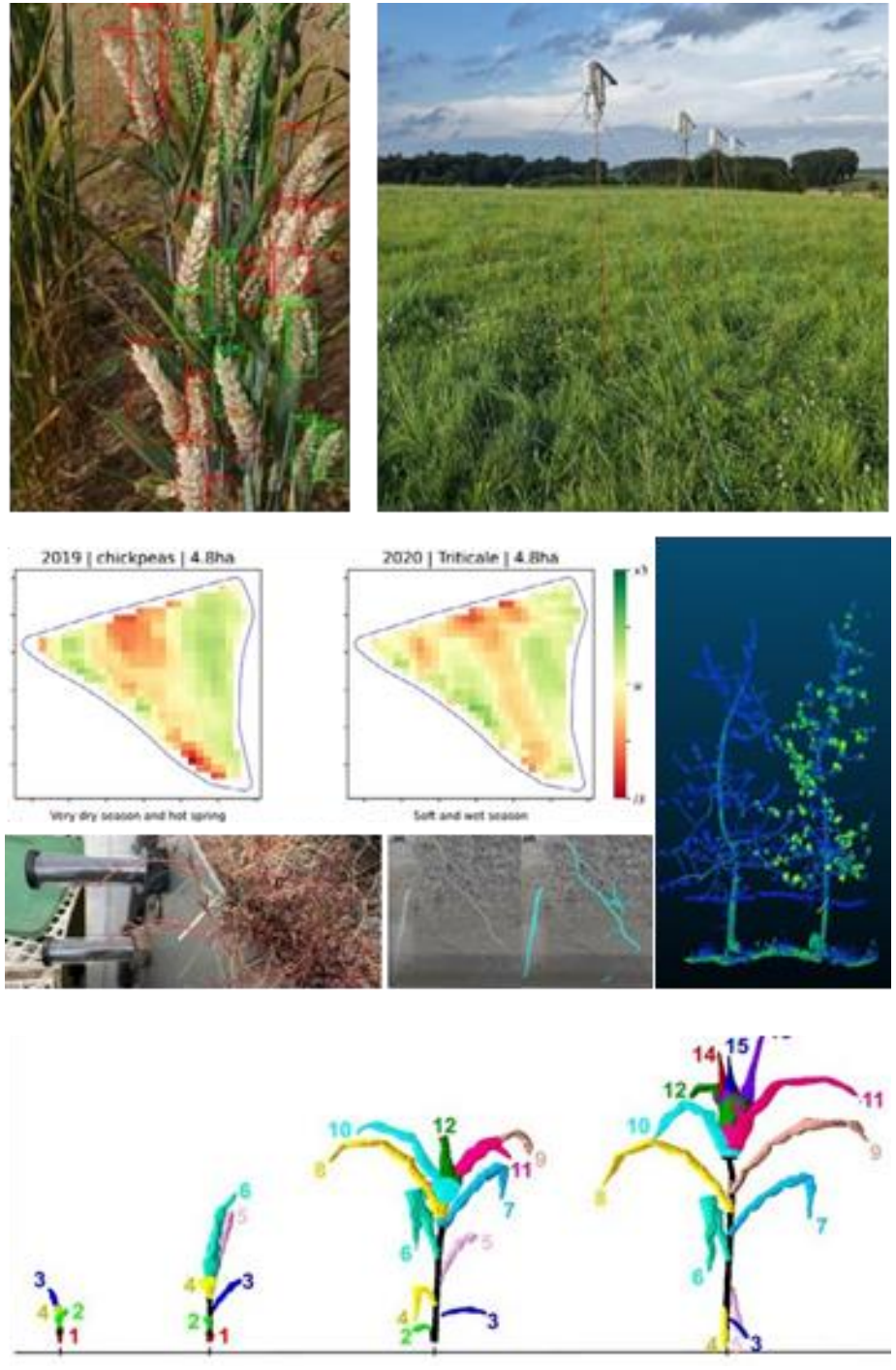
From Cyril Pommier - modified

IN SUMMARY

- PRO-GRACE has made a thorough mapping and gapping needed for GRACE RI
- PGR and phenomics as driver of agricultural transitions
- Use synergies with other RIs and other stakeholders
  - EMPHASIS: Phenotyping
  - ELIXIR: Data
  - Breeders
- How to avoid a „valley of death“?

Plant Phenomics & Enviromics across scales

Edited by
Bertrand Muller
Roland Pieruschka
Xavier Draye
Jörg-Peter Schnitzler



Special Issue

Submission deadline
31 March 2026

Top left Infected and healthy wheat heads as detected by AI models from NIR and RGB images. *Top right* Low- cost connected sticks. *Centre left, top* Heterogenity map based on satellite imaging. *Centre left, bottom* Root in rhizotrons at Ecotron Hasselt. *Centre right* LiDar imaging of apple tree orchards. *Bottom* AI based tracking of individual maize leaves over time.

TRANSNARIONAL ACCESS

AgroServ: sustainable agriculture and agroecological transition

AgroServ
Integrated SERvices supporting a sustainable AGROecological transition

Over 140 services

- 4th call: deadline on 15th of Oct.
- 5th &6 the Call: 2026

Microbes-4-climate: interaction of microbes with soil, plant, atmosphere

MICROBES 4CLIMATE

Over 140 services

- 2nd call opens on Nov. 2025
- 4-5 further calls to follow

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