Phenotyping for crop improvement technologies - access – knowledge

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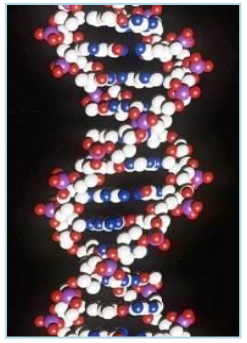
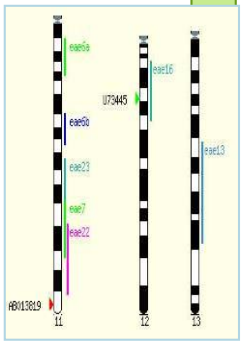
EUROPEAN INFRASTRUCTURE FOR PLANT PHENOTYPING

Plant Phenotyping: contribute to solving challenges



Environment

Genes

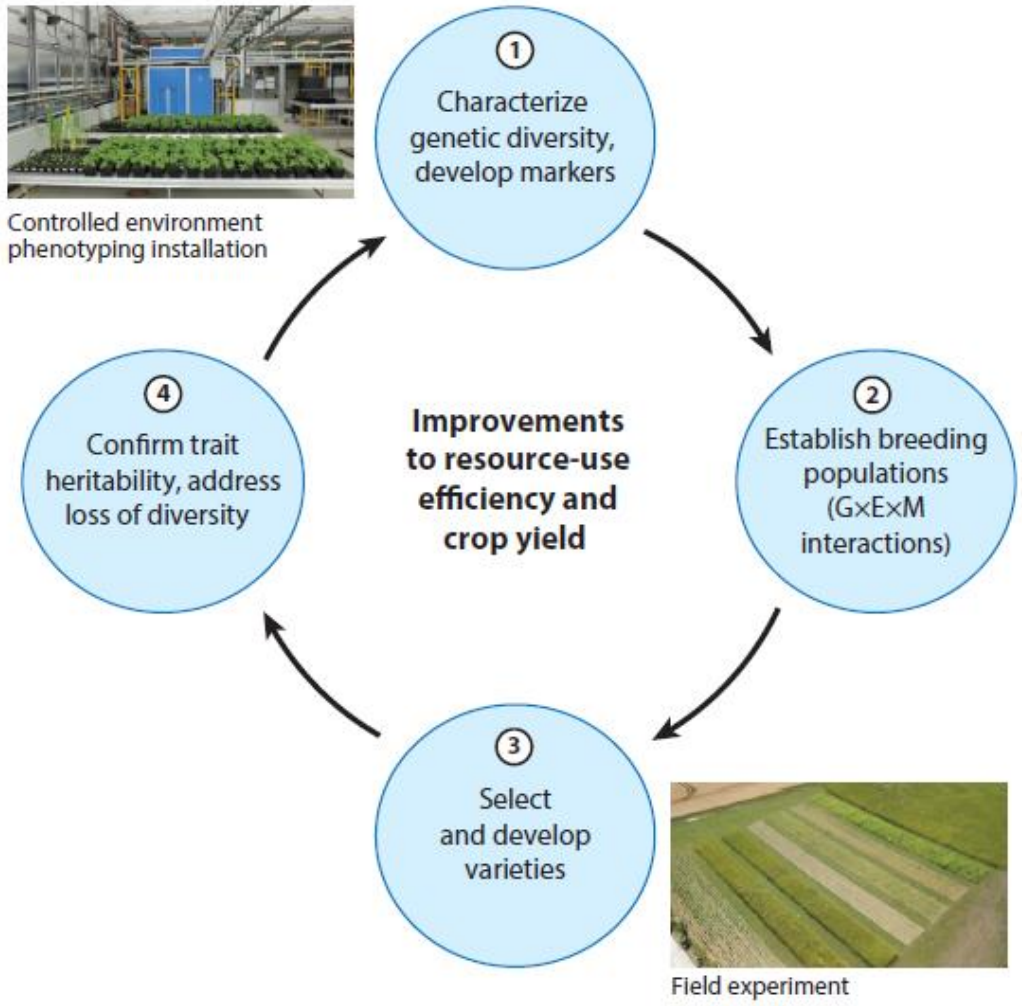





Phenotype:
plant performance and plant production

- Higher quantity and quality of plant biomass production
- Novel characteristics and products
- Yielding in stressful environments
- Sustainable production / intensification

Plant phenotyping to improve crop varieties

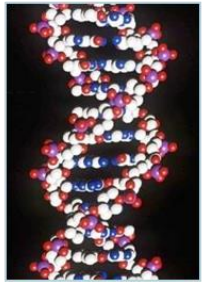


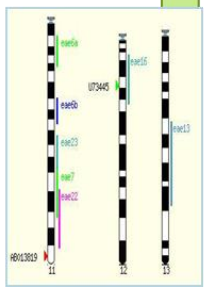
Watt et al (2020)

Growing demand for plant phenotyping as a tool

Environment

Genes





Phenotype: need for quantitative assessment

- Addressing diverse crops and conditions
- Specialized infrastructure: plant characterization, environmental simulation
- Expertise is required, e.g. analysis pipelines, modelling, data re-usability
- Integrated (multi-disciplinary) approaches

EMPHASIS – European Infrastructure for Multi-Scale Plant Phenotyping And Simulation for Food Security in a Chancing Climate

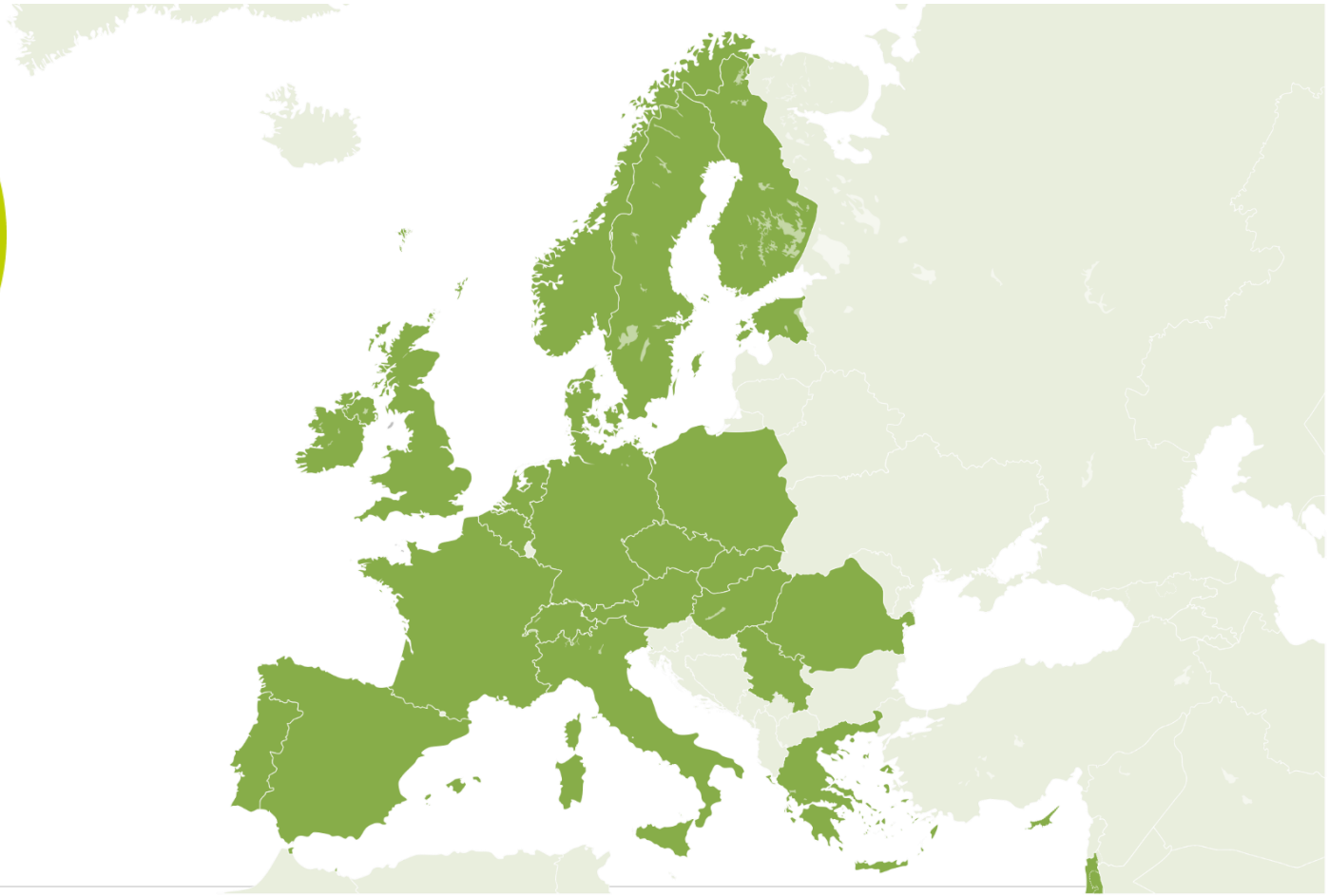
ESFRI

SYNERGY
- Investments
- Data Management
- Education/ Training

INNOVATION
- Unique Installations
- From Academia to Industry

ACCESS
- Development
- Use
- Translation/ Dissemination

24 national communities associated with EMPHASIS



Objectives

DEVELOPING INFRASTRUCTURE AND PROVIDING ACCESS

EMPHASIS: integrating plant phenotyping in Europe

- 2016: EMPHASIS on the ESFRI Roadmap

Preparatory Phase (2017-2020)

- Funded via a H2020
- Evaluate the phenotyping landscape in Europe
- Development of business plan with user strategy, governance, …

Implementation Phase (2019-2021)

- Implement to the long-term operations
- Engage countries (currently 11 ministries): decision making for future of operations / funding
- Set up of EMPHASIS pan-European Services

Operational Phase (2022/23 onwards)

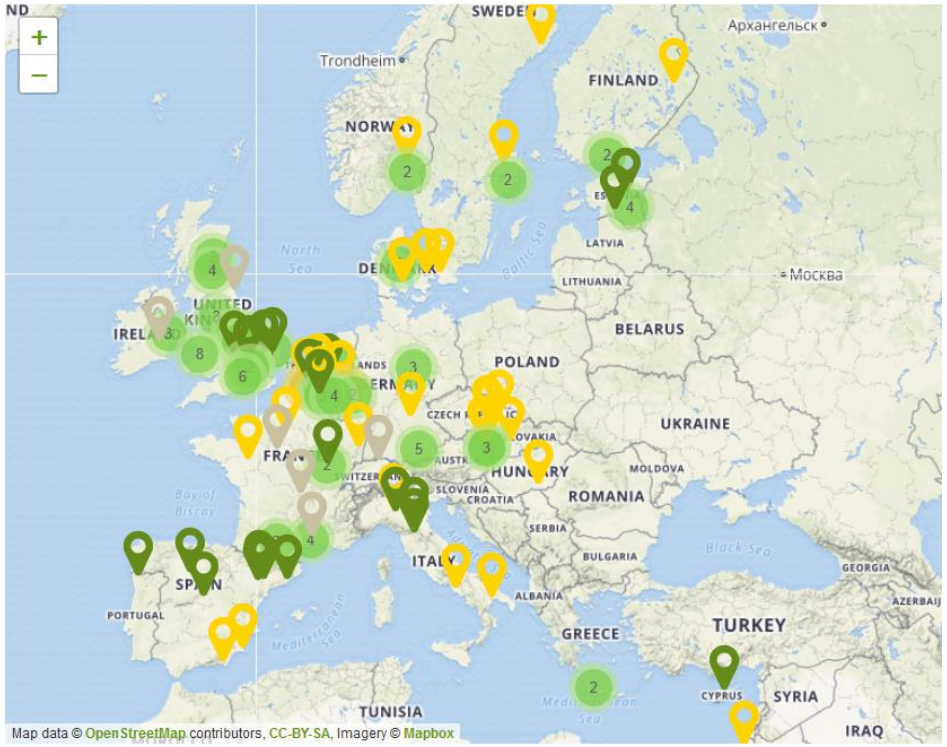
- Long-term legal entity is in place
- Sustainable operation is ensured
- Access to facilities, resources and services is in place

ESFRI

Infrastructure in EMPHASIS

PLANT PHENOTYPING REQUIRES INTEGRATED CONCEPTS

TO FULLY EXPLORE ITS POTENTIAL



Source: EMPHASIS homepage (https://emphasis.plant-phenotyping.eu/emphasis_infrastructure_map)

CONTROLLED CONDITIONS

- ✓ Greenhouses and growth chambers
- ✓ Monitoring of environmental conditions
- ✓ Throughput typically between 100-1000s plants

LEAN FIELD

- ✓ Field trials with environmental monitoring
- ✓ Phenotyping equipment for basic traits
- ✓ ground based or airborne sensing systems

INTENSIVE FIELD

- ✓ Detailed environmental monitoring
- ✓ High quality phenotyping measurements
- ✓ Semi-controlled intensive field sites

MODELLING

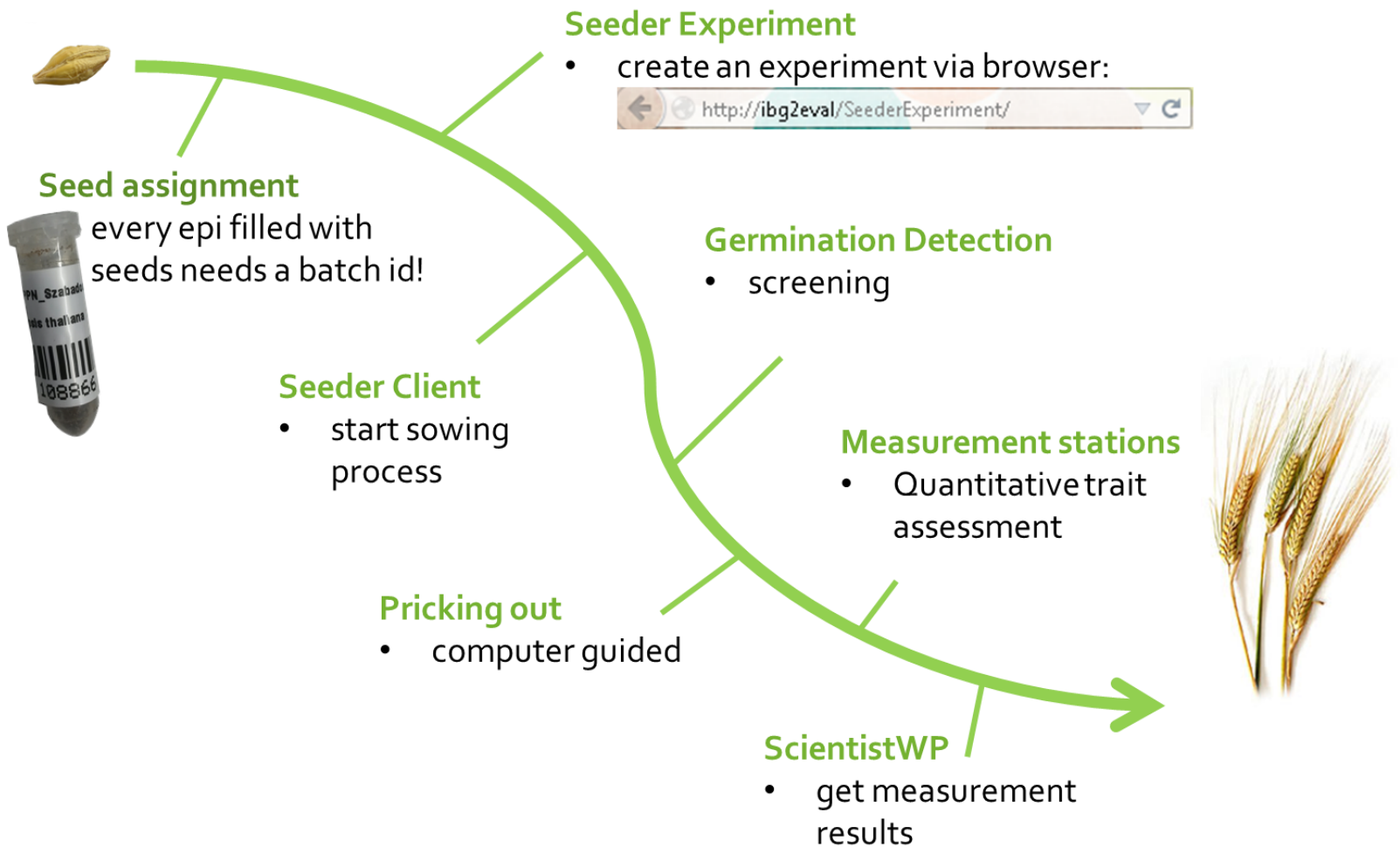
- ✓ Virtual platforms
- ✓ Different types of models: Crop Models, FSPM
- ✓ integrated or interfacing with installations

DATA & COMPUTATIONAL SERVICES

- ✓ FAIR Information systems plant phenotyping data
- ✓ Access to data
- ✓ integrated information systems

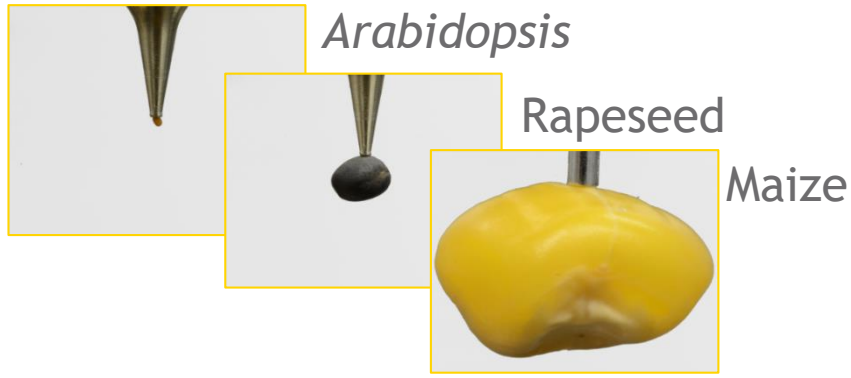
Example: shoot traits for improved plant productivity

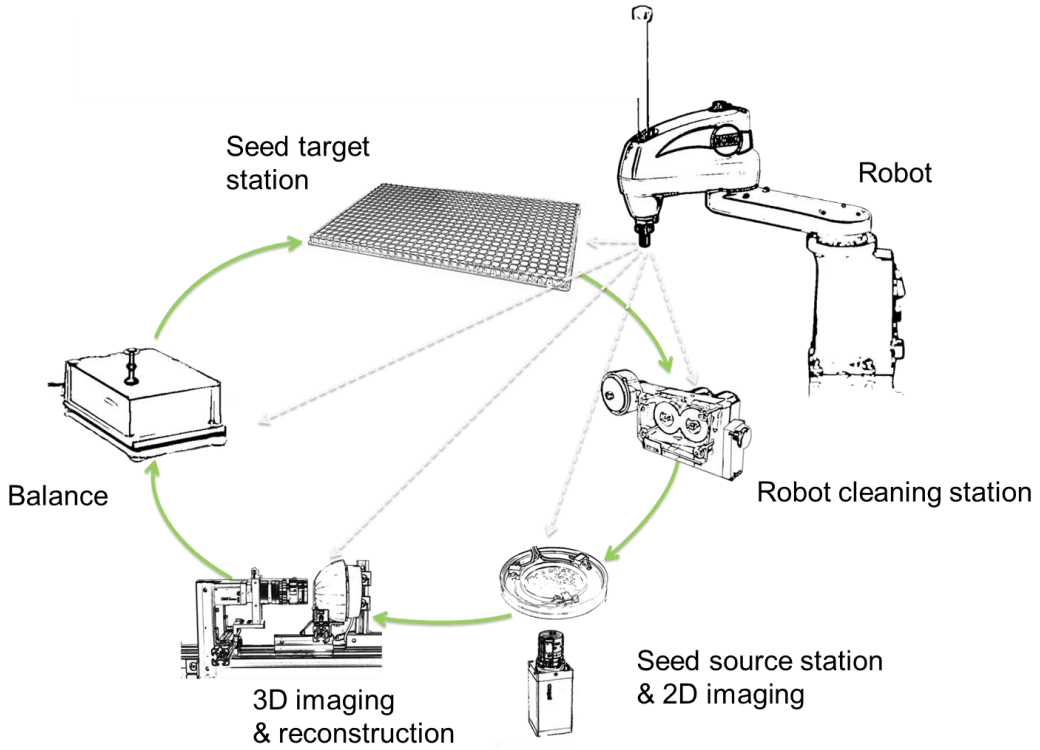
Phenotyping piplines



PhenoSeeder: Phenotyping of structure and function of seeds

A robot system for **phenotyping single seeds**





Jahnke et al., 2016, Plant Physiol., modified

Jahnke et al (2016)

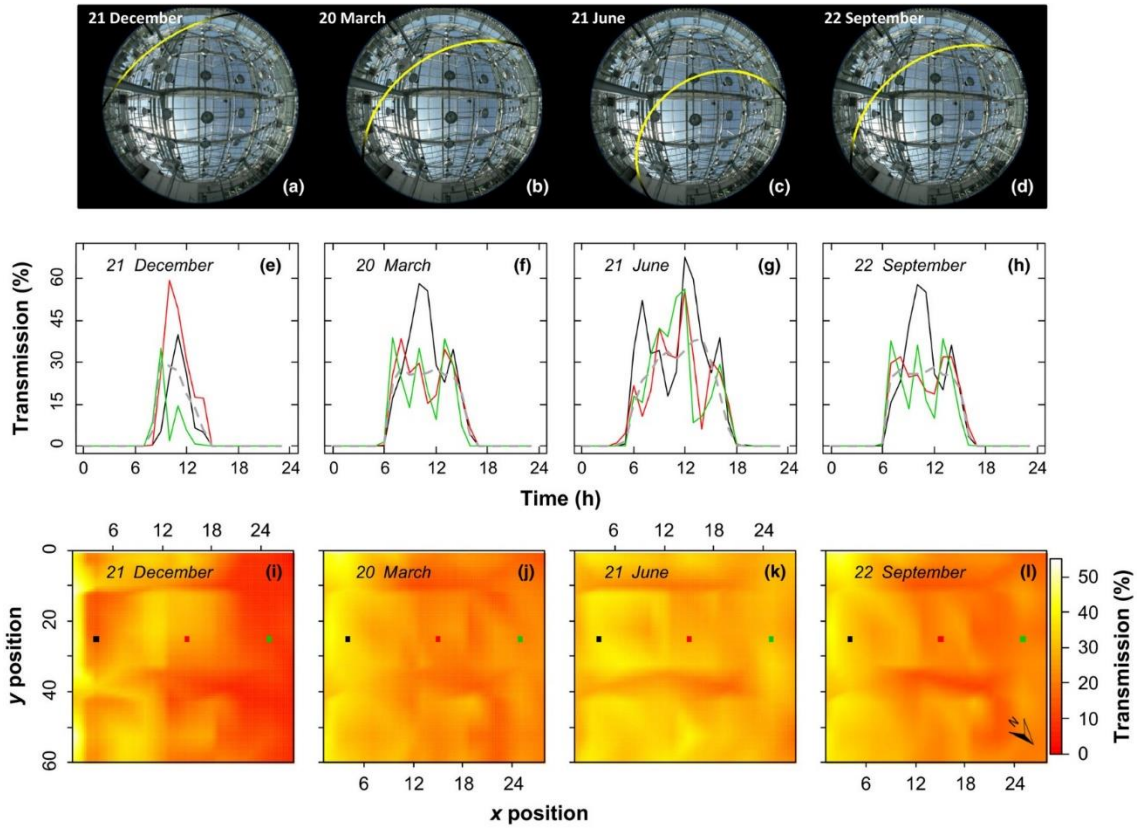
Phenotyping of shoot structure and key functions

INTEGRATED CONCEPTS AND IMPLEMENTATIONS FOR HIGH THROUGHPUT

Growth Facilities

plant to sensor / sensor to plant…

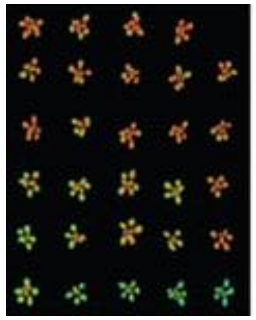
Environmental simulation and monitoring



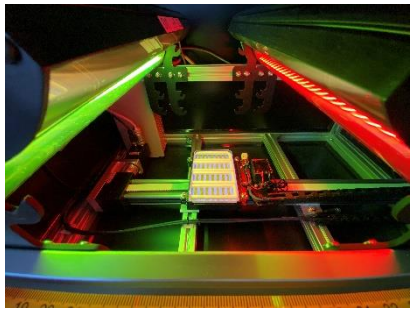
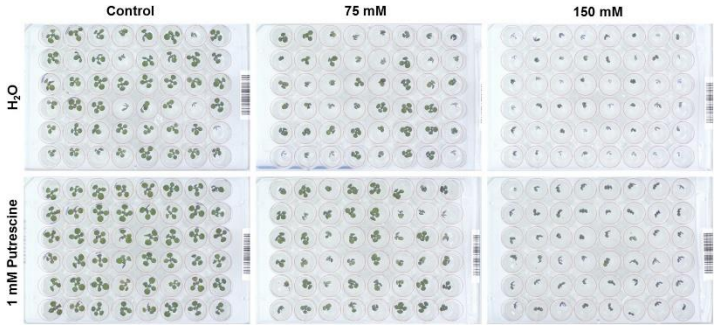
Cabrera-Bosquet et al (2016)

Phenotyping of shoot structure and key functions

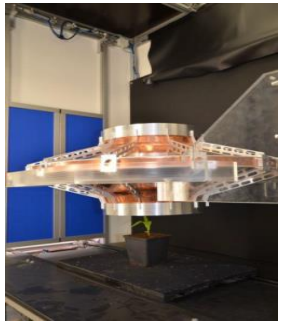
Photosynthesis
(gas exchange, fluorescence methods)

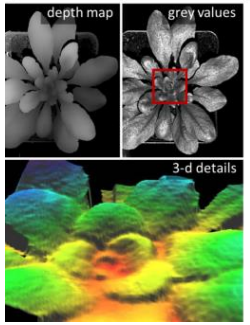

Biotic interactions
(hyperspectral imaging, 2D RGB imaging)

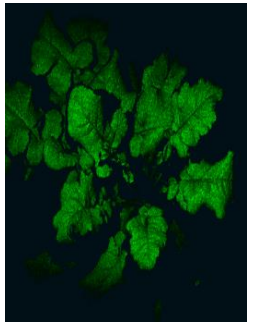
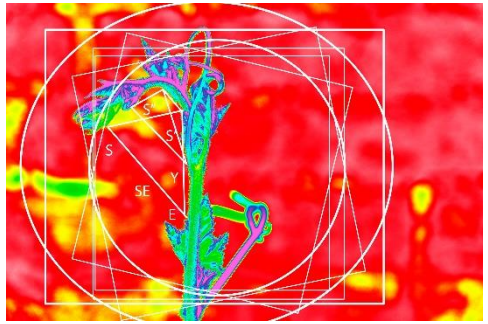



Water relations
(gravimetric, microwaves)

Growth, biomass and shoot structure
(2D / 3D RGB imaging)



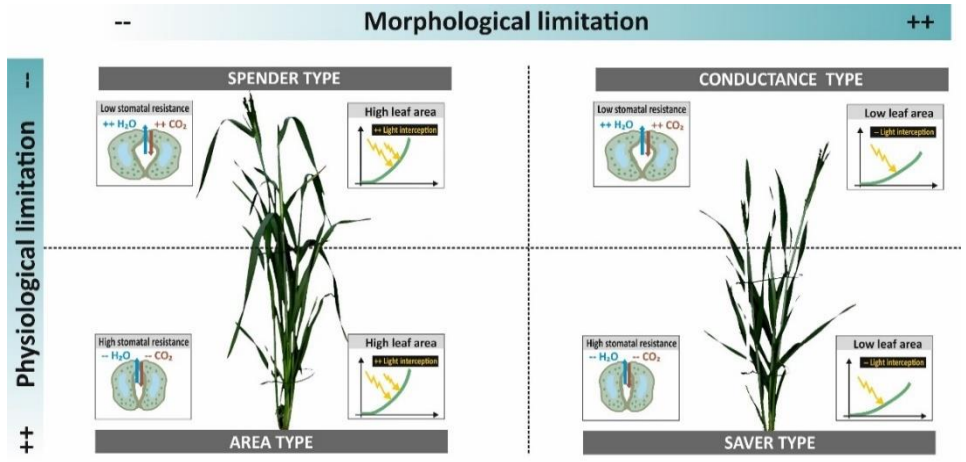



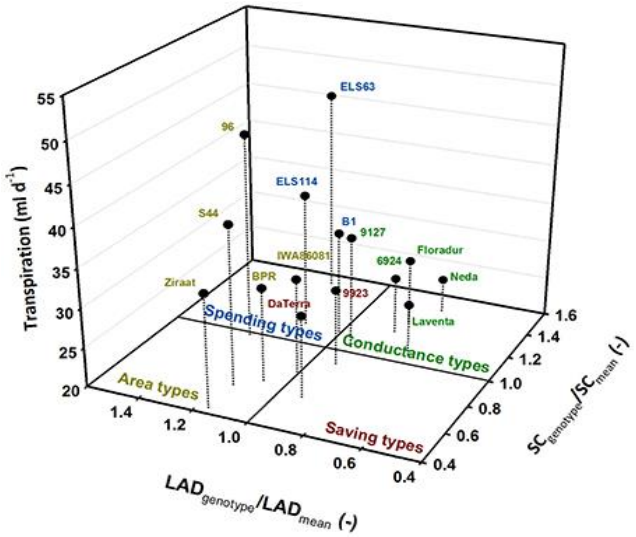
Example: Contrasting genotypes for strategies for water acquisition

TNA scheme FP/ H2020 funded with >200 experiments

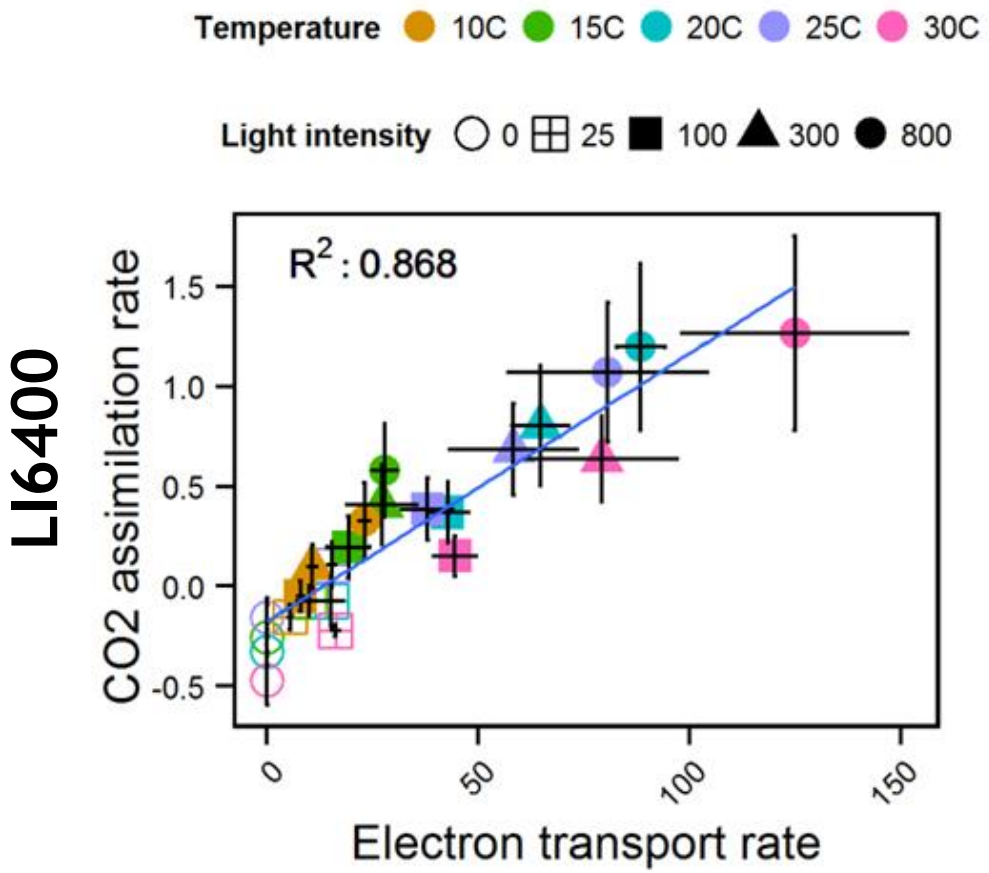
- Water use strategies for crop productivity in different drought environments

- Assess morphological and functional limitations





Example: Measurement of photosynthetic properties with the LIFT

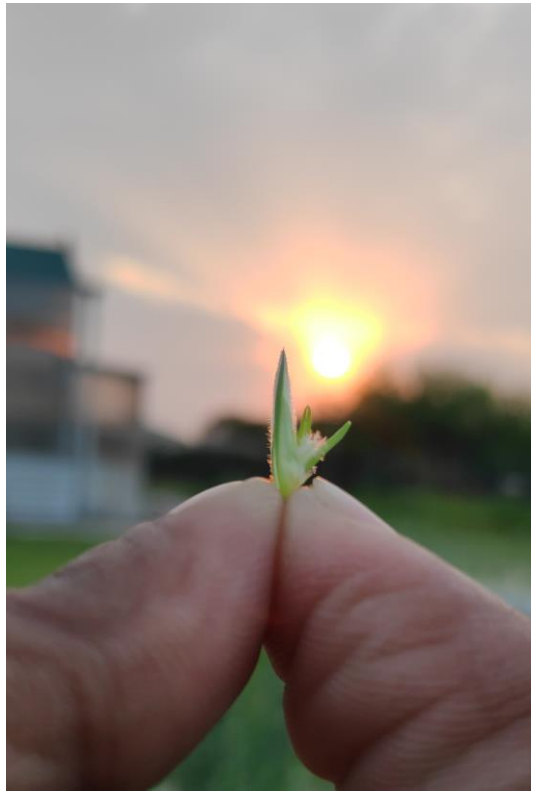


Keller et al. 2019

Phenotyping chains

Practical experiments

From single plant to field



(Poorter et al 2016)

Phenotyping chains

Practical experiments

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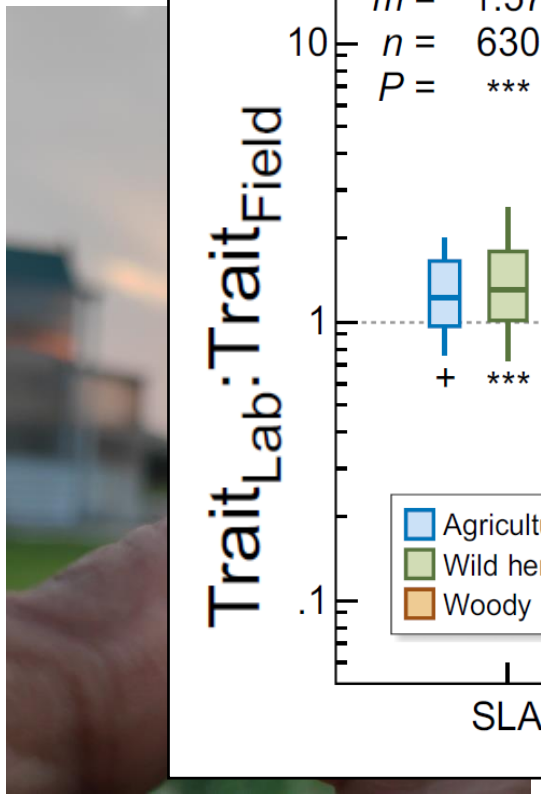


	r^2
Lab to field	0,26
Field to field	0,08

(Poorter et al 2016)

Data Management

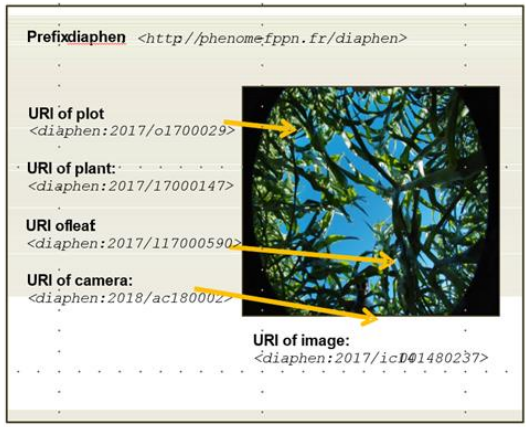
Pan-European Information system

BrAPI

miappe

All objects have unambigouous identifyers (cameras, plants, pots, sensors)

Findable / Reusable



Controlled vocabulary (ontologies) for

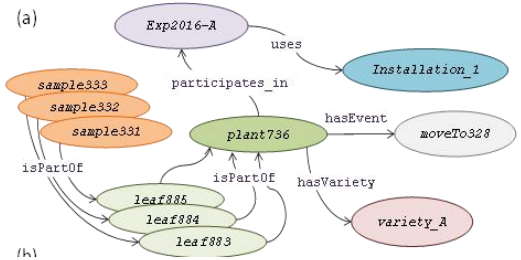
- Objects
- Events
- Traits

Standardize or track/map names with:

'triplet': definition/method/unit

Reusable

semantic web allows auto-matic metadata collection

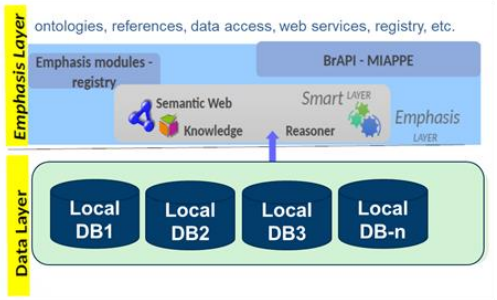


Webservices for linking Phenotyping centers

Findable / Accessible / Interoperable

EMPHASIS -Layer

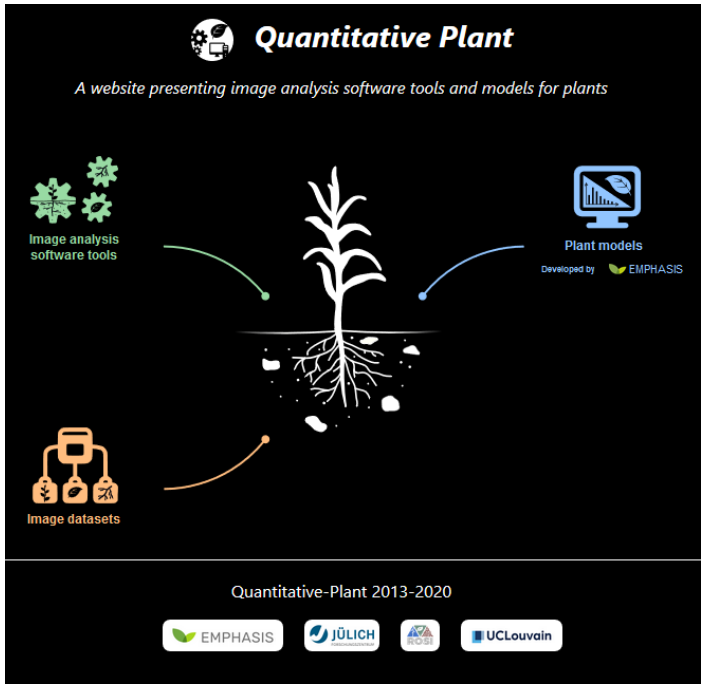
Adapter linking data bases



Long term storage Policy

Findable / Accessible

Modelling



https://www.quantitative-plant.org/model

Acknowledgement

EMPHASIS PREP

- Uli Schurr, FZJ
- Sven Fahrner, FZJ
- Lisa Vincenz-Donnelly, FZJ
- Asis Hallab, FZJ
- Constantin Eiteneuer, FZJ
- Dan Wang, FZJ
- Michela Janni, CNR
- Silvana Moscatelli, CNR
- Francesco Loreto CNR
- Malcolm Bennett, UNOT
- Darren Wells, UNOT
- Tony Pridmore, UNOT
- Francois Tardieu, INRAE
- Jean-Eudes Hollebecq, INRA
- Richard Traini, BBSRC
- Stijn Dhondt, VIB
- Merlijn Morisse, VIB
- Xavier Draye, UCL
- Clément Saint Cast UCL
- Rick van de Zedde, WUR

EMPHASIS

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ESFRI

EMPHASIS is an ESFRI-listed project.

EMPHASIS-PREP is funded by the
European Union (Grant Agreement: 739514).

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