

OVERCOMING THE PHENOTYPING BOTTLENECK

BY INTEGRATED APPROACHES

ULI SCHURR

WITH SPECIAL THANKS TO
ROLAND PIERUSCHKA
SVEN FAHRNER
SIMONE GATZKE



Mitglied der Helmholtz-Gemeinschaft

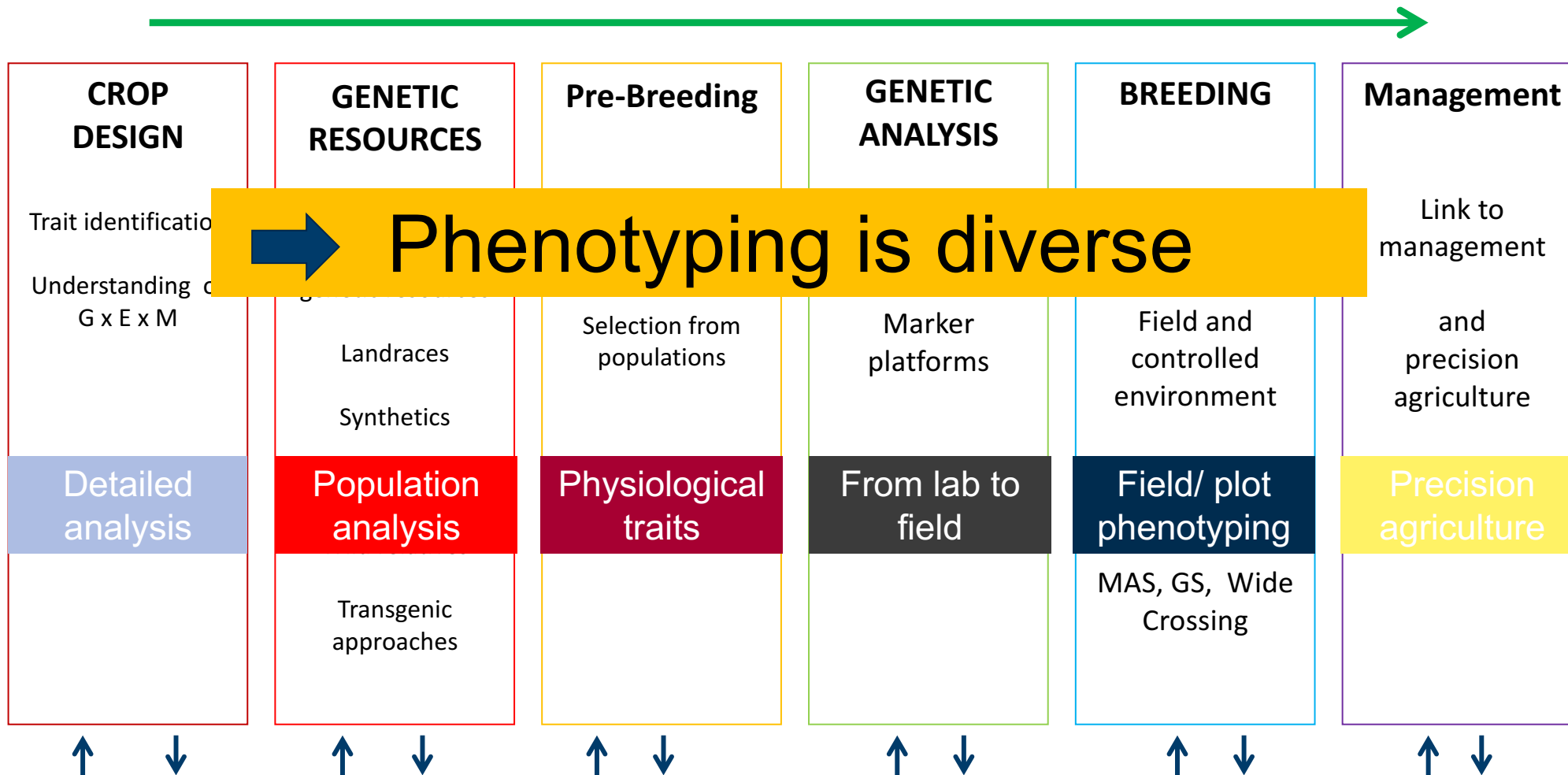


Phenotyping Challenges

Phenotyping in breeding and plant management



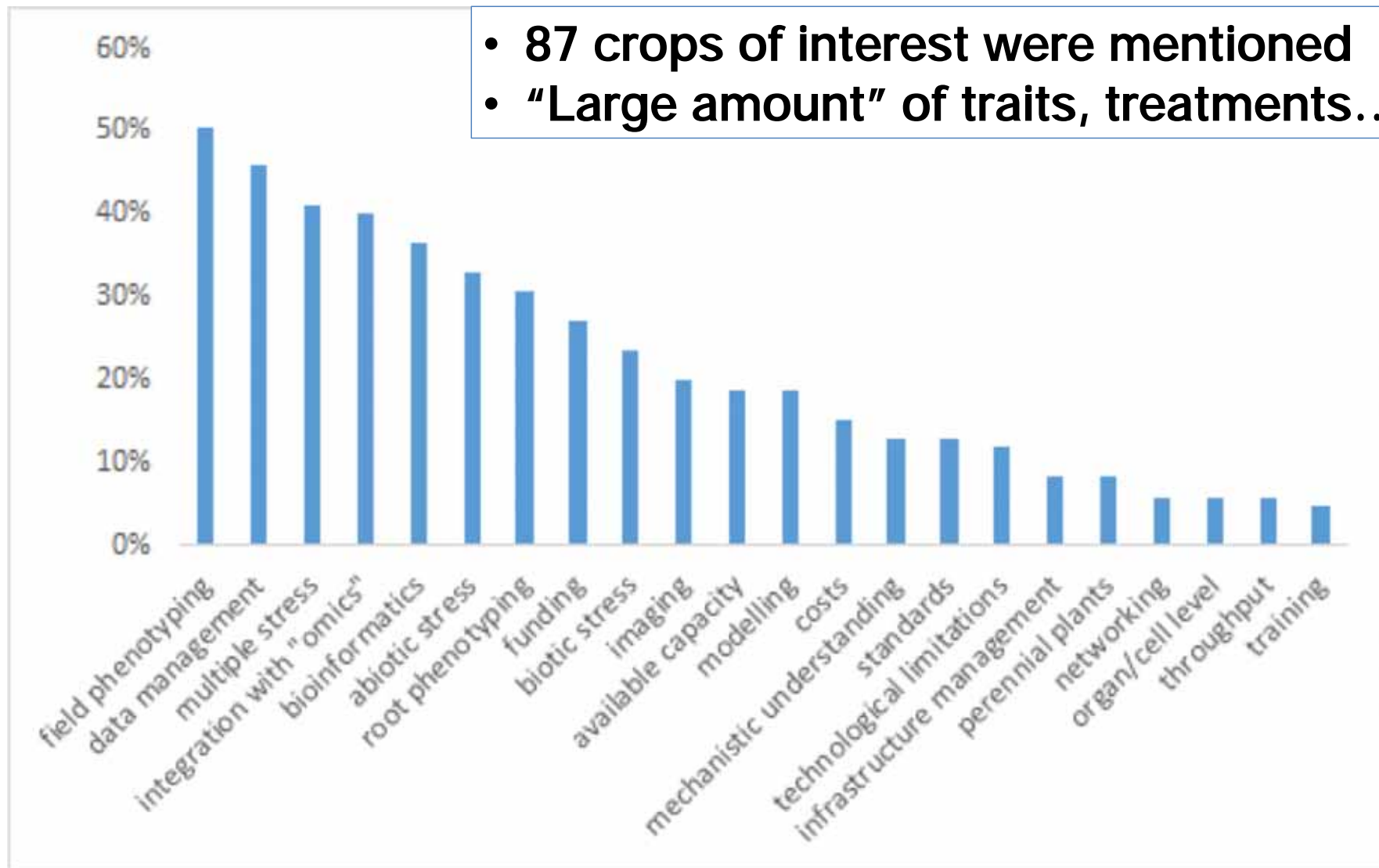
Breeding Objective: e.g. enhancing yield and biomass through optimizing plant phenomics



DATA MANAGEMENT and MODELLING



Diverse challenges in plant phenotyping



Automation
Robotics

Image
Analysis

Machine
Learning

Novel
Sensors

Big Data



Phenotyping requires
networks and Interaction

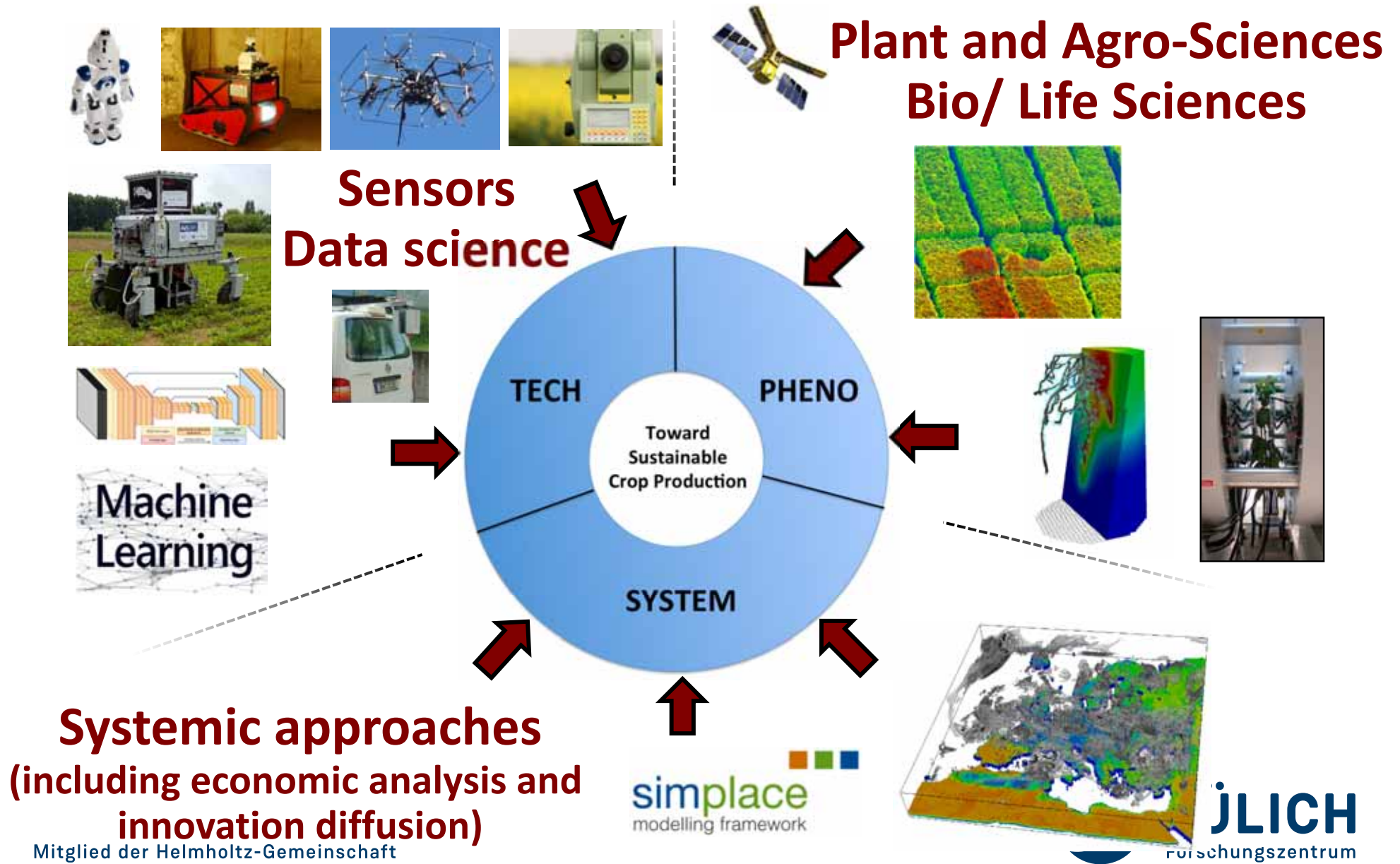
Integration of
omics with

physiology
Integration of

biological and environmental
knowledge along the entire life cycle

Time and space scales
can be addressed

INTEGRATING EXPERTISE FOR ADVANCED PLANT PHENOTYPING



Integrating National and International efforts



National platforms



NaPPI



Regional Projects / Networks



Crop specific aspects

General development



International networks

Integrating National and International efforts



National platforms



Regional Projects / Networks



European Infrastructure

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

EMPHASIS – why going European?

ESFRI



SYNERGY

- Investments
- Data management
- Education/ Training

INNOVATION

- Unique installations
- From academia to industry



ACCESS

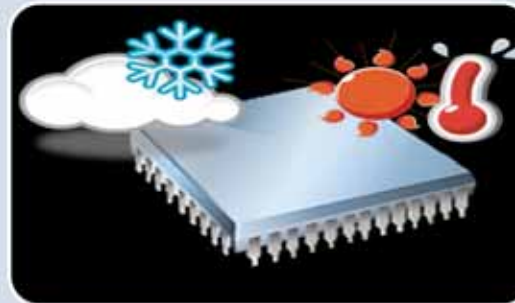
- Development
- Use
- Translation/ Dissemination

Developing infrastructures and providing access to analyze genotype performance in diverse environments

Objectives



Develop an integrated pan-European infrastructure of instrumented facilities available to the user community

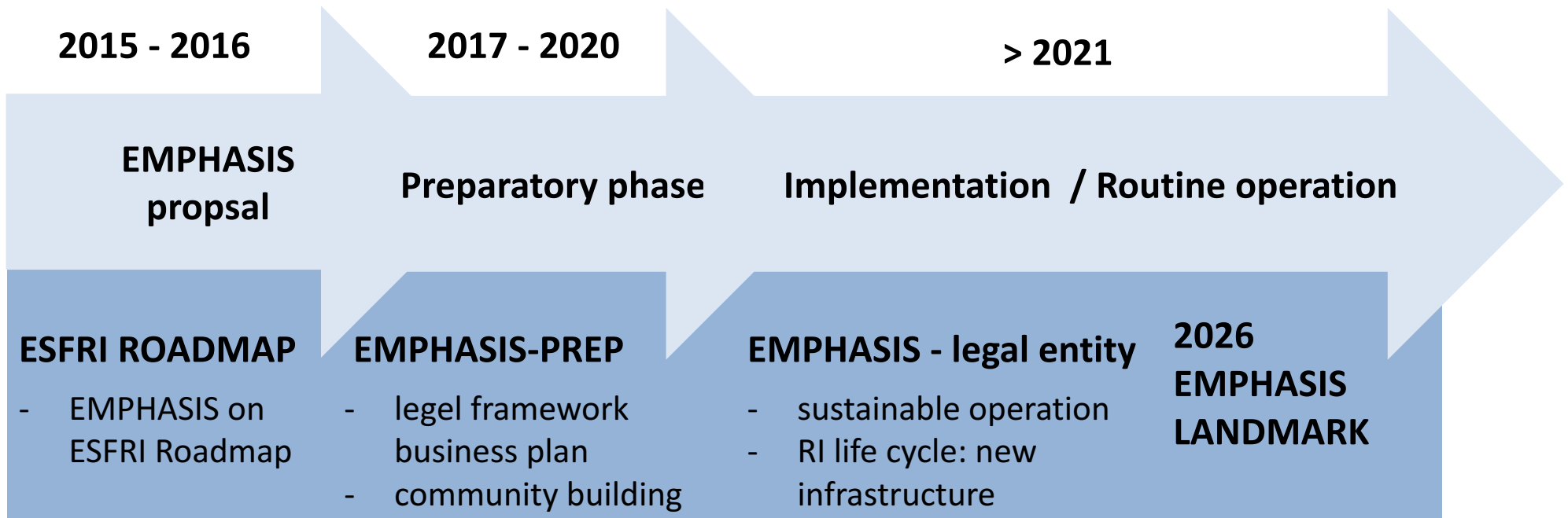


Link data acquisition to a European-level data information system and modelling



Develop, evaluate and disseminate knowledge and novel technologies providing innovative opportunities for academia & industry

EMPHASIS: (further) developing the European Plant Phenotyping Community



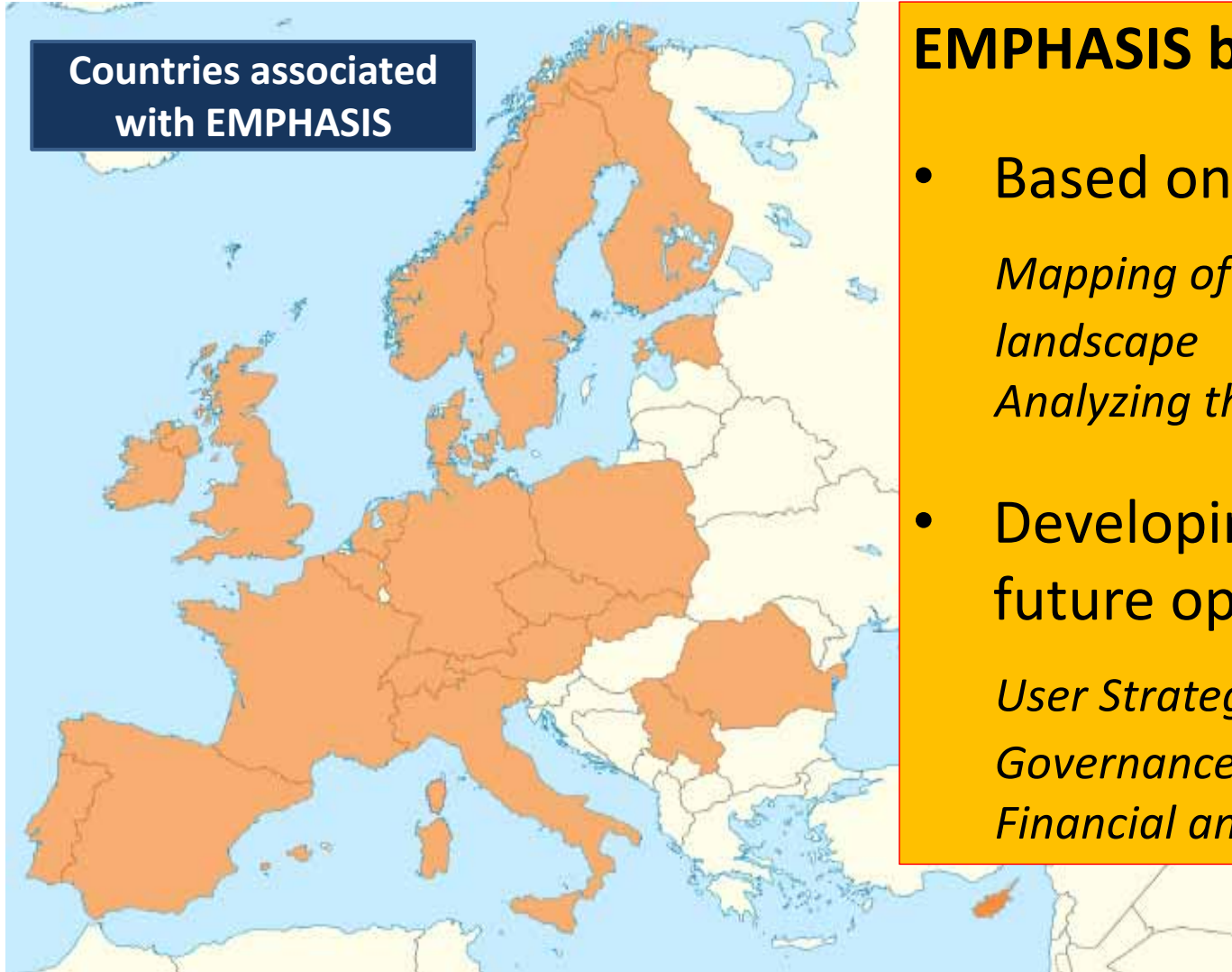
- Advancing and supporting the formation of national Plant Phenotyping Networks
- Connecting national PPN in Europe and with global activities
- Developing links between stakeholders and disciplines
- Developing standards and support implementation
- “Political engineering” for plant phenotyping with a European perspective
- Supporting innovation in Plant Phenotyping along the entire pipeline

Pan- European integrated plant phenotyping infrastructure

ESFRI



Countries associated
with EMPHASIS



EMPHASIS business plan

- Based on
 - Mapping of plant phenotyping landscape*
 - Analyzing the gaps*
- Developing strategies for future operation
 - User Strategy*
 - Governance and Organization*
 - Financial and Funding Framework*

European and global phenotyping activities



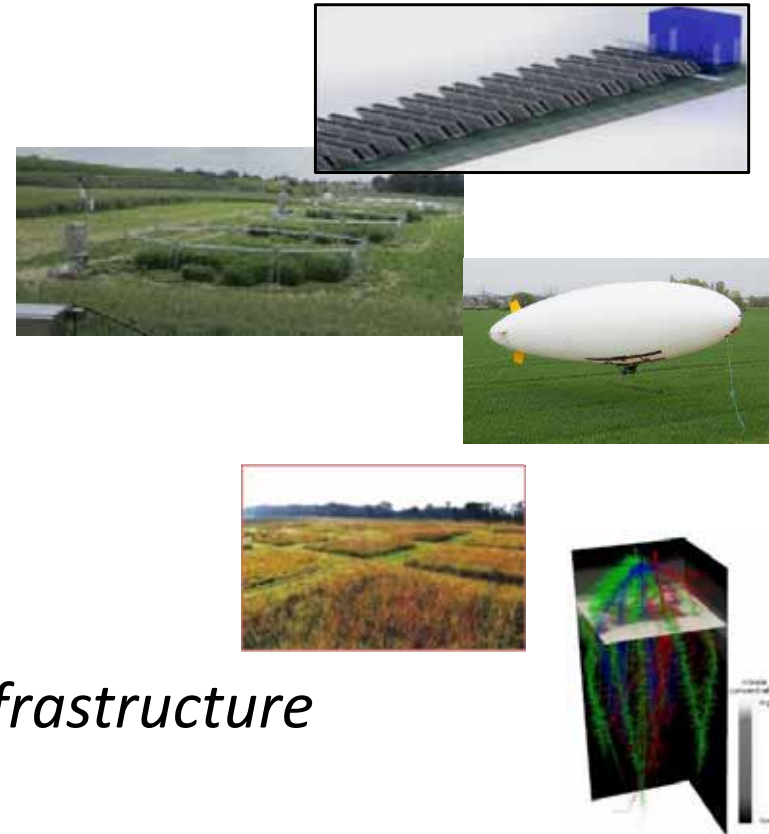
C-PPI: DEEP-Phenotyping Platforms

IF-PPI: Intensive Field Platforms

LF-PPI: Lean Phenotyping

M-PPI: Modelling Platforms

E-PPI: Joint data management and e-infrastructure



Discussing demands and options with crop-specific and topic-specific communities



Cereals



Model crops



Wider science community



COST Action FA1306:
The quest for tolerant varieties –
Phenotyping at plant and cellular level



Pathology



Seed bank



Horticulture



Grapevine



Roots

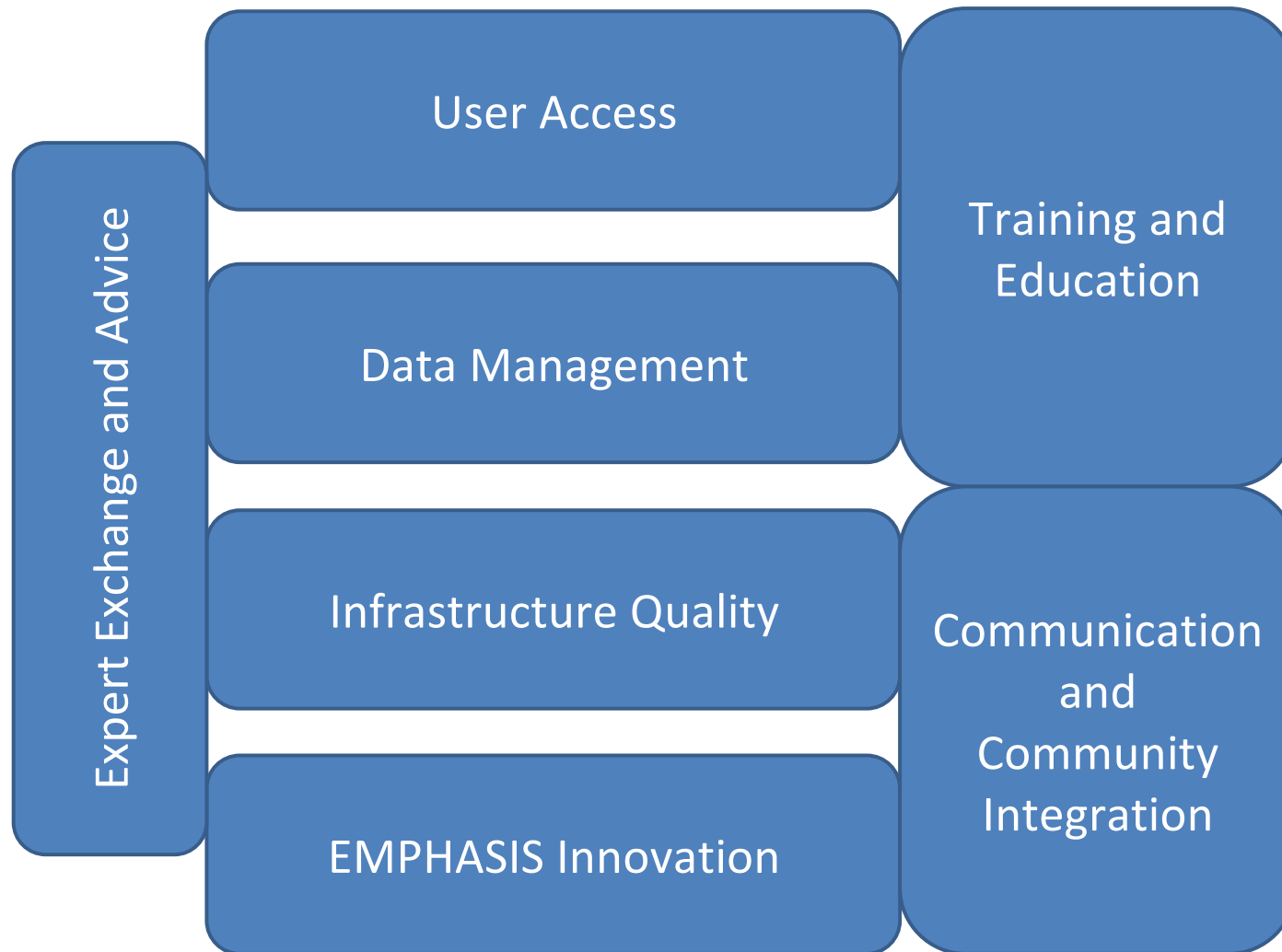


Seed bank



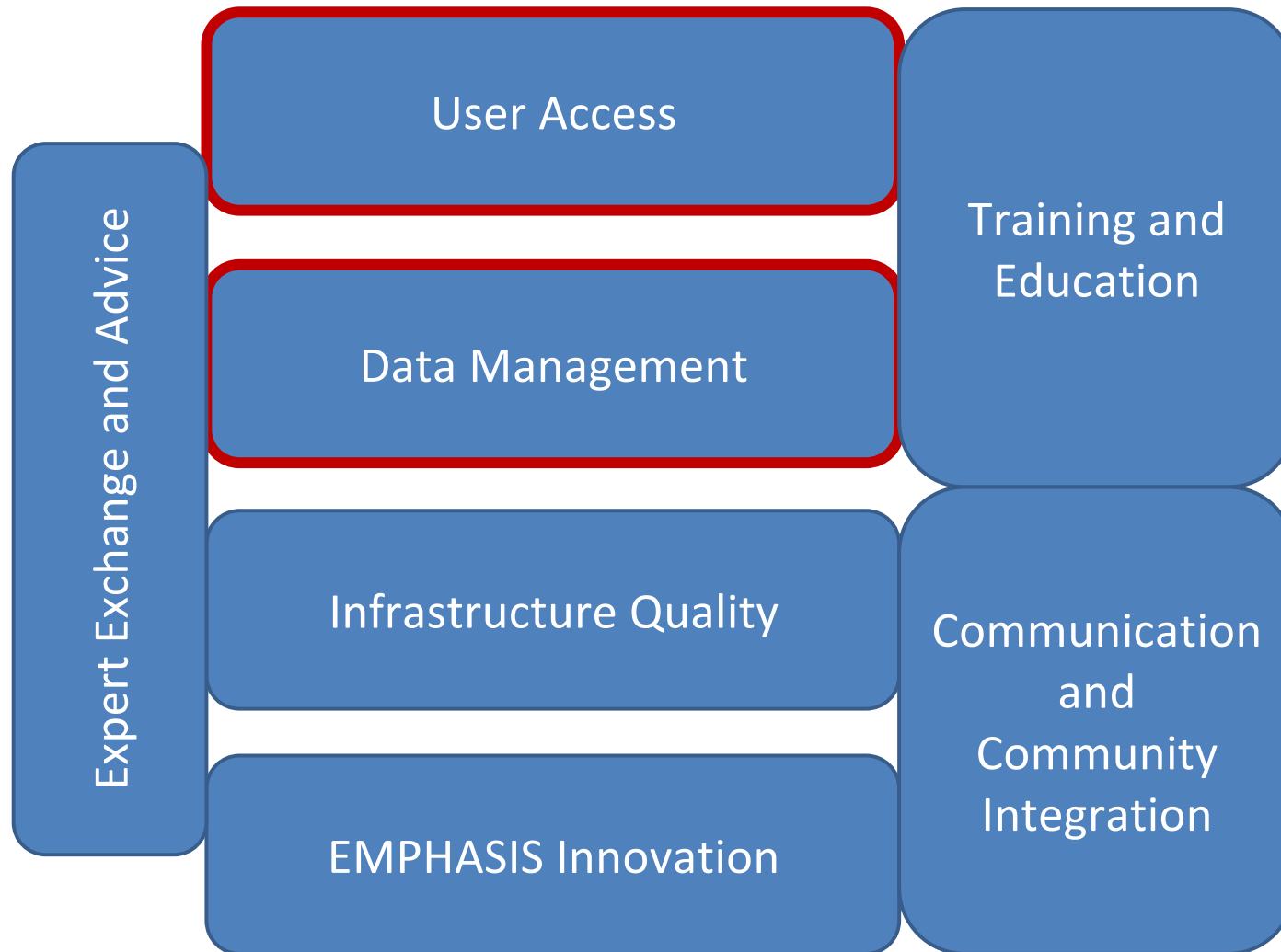
EMPHASIS: fields of potential services

ESFRI



EMPHASIS: fields of potential services

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Providing access today: EPPN and EPPN2020



2012-2015

Access to 23 installations

- 66 experiments

>50 peer reviewed publications

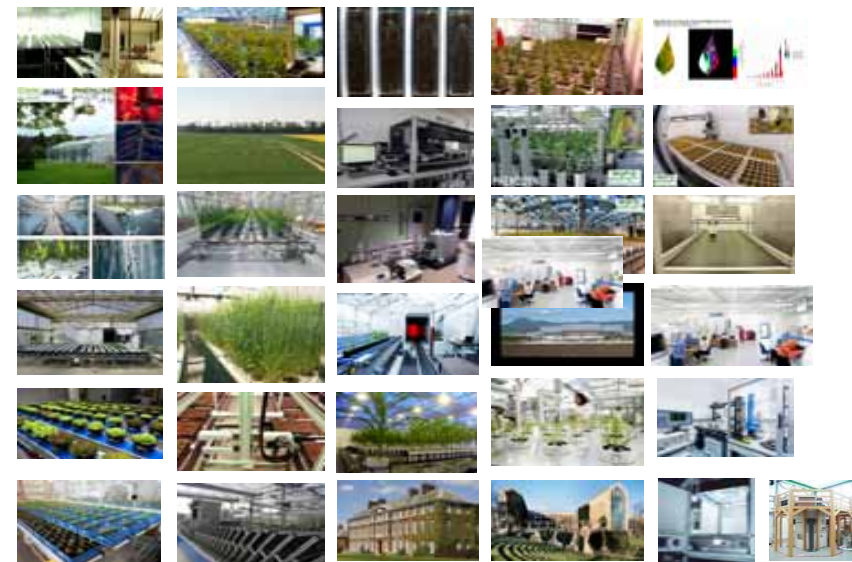
~200 users directly involved



2017-2021

Access to 31 installations

~ 200 experiments



European Plant Phenotyping Network Projects

3rd call for access
in mid-September 2018



2017-2021

Access to 31 installations in Europe

<https://eppn2020.plant-phenotyping.eu/>



Based on a simple application procedure



Calls every 6 months



Full cost of projects covered by the project, including travels



20% accesses for non-European

Preparing Access in the future: EMPHASIS

Interactive map of infrastructures



Searchable database of infrastructure
(already > 120 infrastructures listed)

Details of Plant Phenotyping installations

Show entries

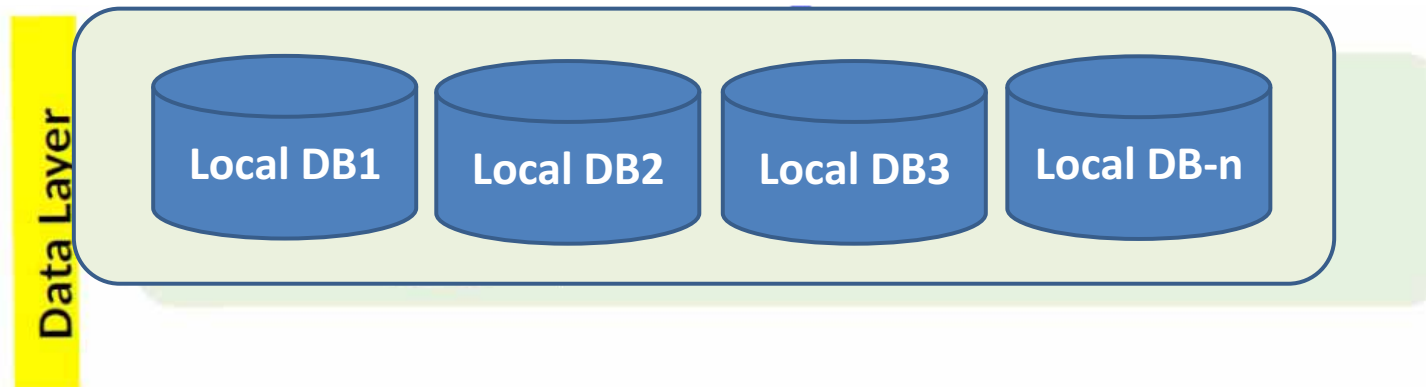
Search:

ID	Country	City	Organisation	Installation.Category
1	United Kingdom	Nottingham	Nottingham	controlled conditions
2	France	Dijon	INRA	controlled conditions
3	France	Dijon	Terres Inovia	(network of) lean field(s)
4	Belgium	Louvain-la-Neuve	UCLouvain Earth and Life Institute	controlled conditions
5	Italy	Metaponto di Bernalda	ALSIA	controlled conditions
6	Germany	Gatersleben	IPK Gatersleben	controlled conditions
7	Germany	Gatersleben	IPK Gatersleben	controlled conditions
8	Germany	Gatersleben	IPK Gatersleben	controlled conditions
9	Belgium	Leuven	KUL	controlled conditions
10	Germany	Jülich	Forschungszentrum Jülich	highly equipped fields

Showing 1 to 10 of 121 entries

Previous 2 3 4 5 ... 13 Next

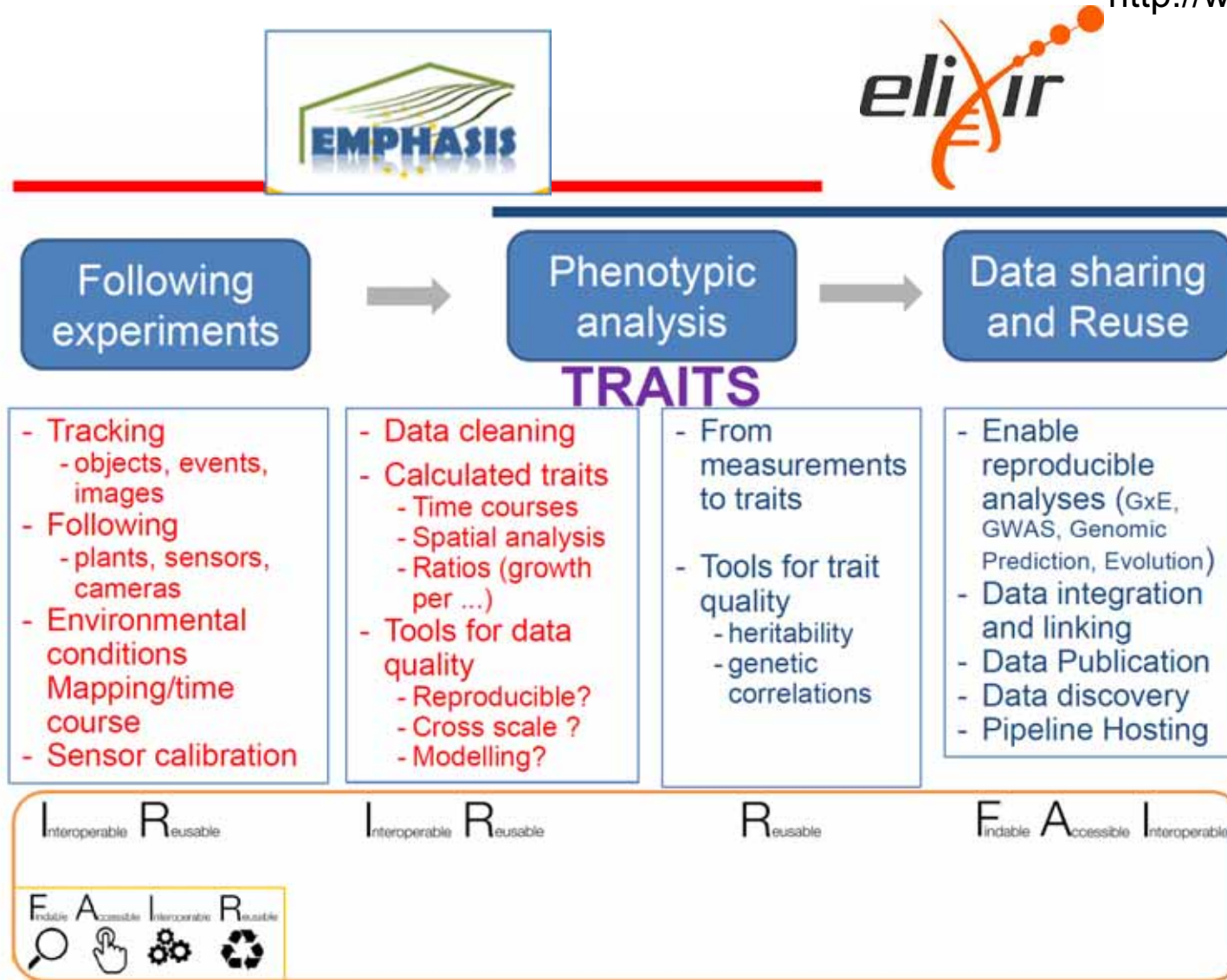
Single web based entry point to query all databases



Minimum Information About a Plant Phenotyping Experiment



<http://www.miappe.org/>



Plant phenotyping beyond Europe



**International
Plant
Phenotyping
Network**

IPPN

IPPN - a global association for Phenotyping

Open for new members



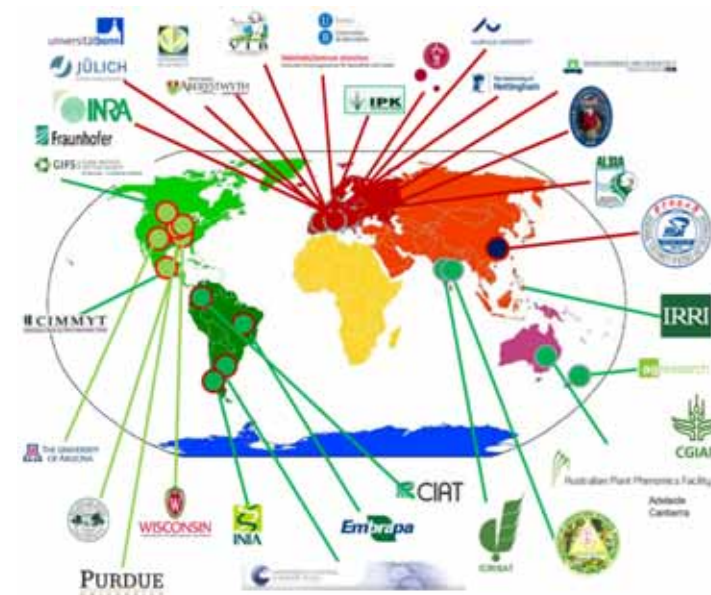
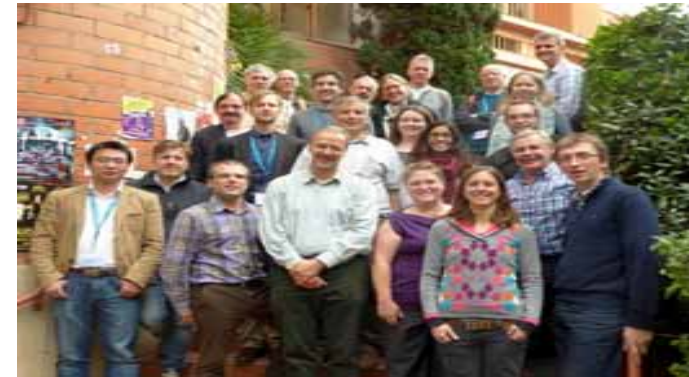
Non-profit association to integrating the community across the globe – founded in Dec. 2015

Goal:

- Integrating the globally fragmented activities from academia and industry
- Enabling exchange of knowledge, information, and expertise

Instruments:

- Organizing International Plant Phenotyping Symposia
- Establishment of Working Groups on different topics
- Organization of workshops, meeting, summer schools, etc.
- Development of interactive communication platforms



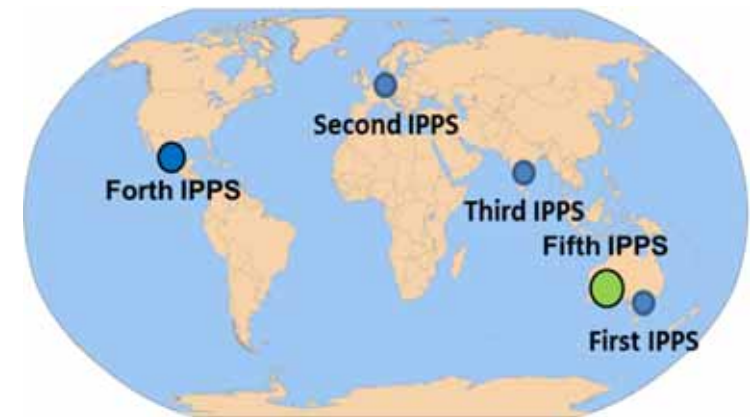
Learn more ...



5th Internatioanl Plant Phenotyping Symposium

From plant - To data - To impact

2-5th of October 2018,
Adelaide, Australia



5TH INTERNATIONAL PLANT PHENOTYPING SYMPOSIUM | 2-5 OCTOBER 2018 | ADELAIDE, AUSTRALIA | WWW.IPPS2018.COM.AU



OVERCOMING THE PHENOTYPING BOTTLENECK BY INTEGRATED APPROACHES

SPECIAL THANKS TO

THE OPERATIONAL TEAM OF EMPHASIS-PREP

THE EXECUTIVE COMMITTEE OF EMPHASIS-PREP

THE SUPPORT-GROUP OF EMPHASIS



Mitglied der Helmholtz-Gemeinschaft



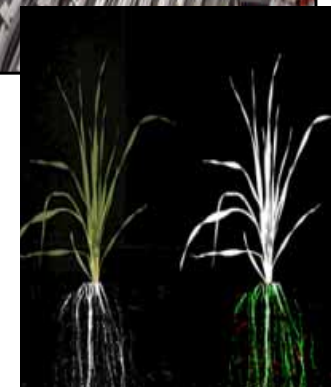
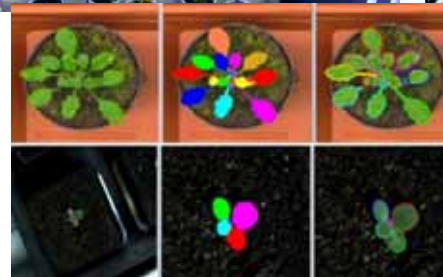
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1. Facilities for high resolution, high throughput phenotyping



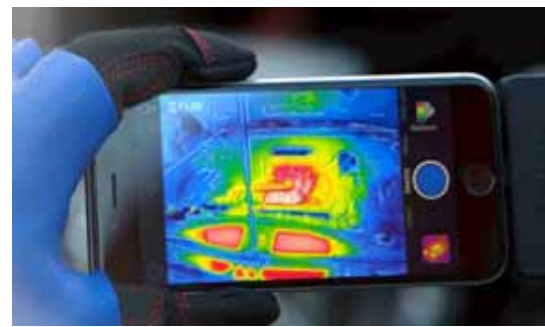
Maize root system (see Fig. 4c)
Grey: MRI imaging (isosurface)
Colours: PET imaging: import of 11C-tracer



2. Semi-controlled field systems for high throughput phenotyping

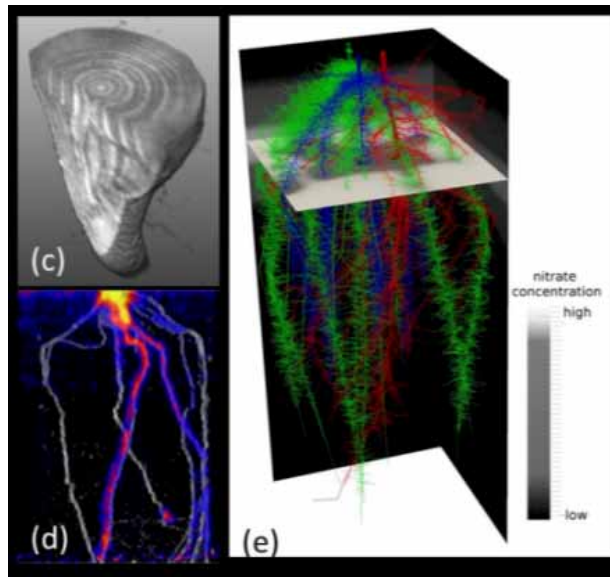


3. Network of field sites practical experiments

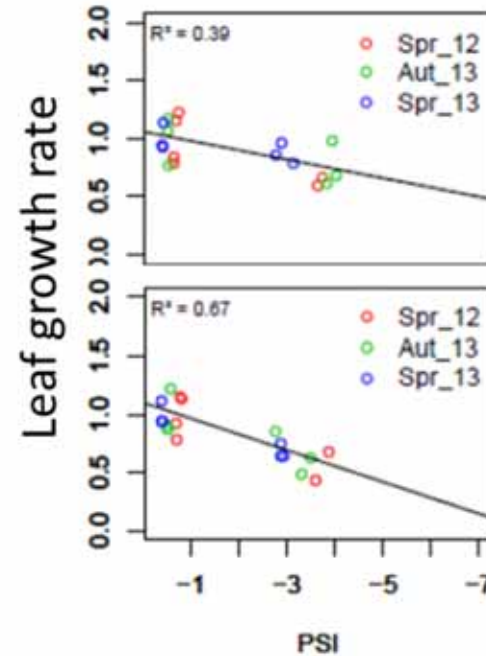


4. Modelling platform

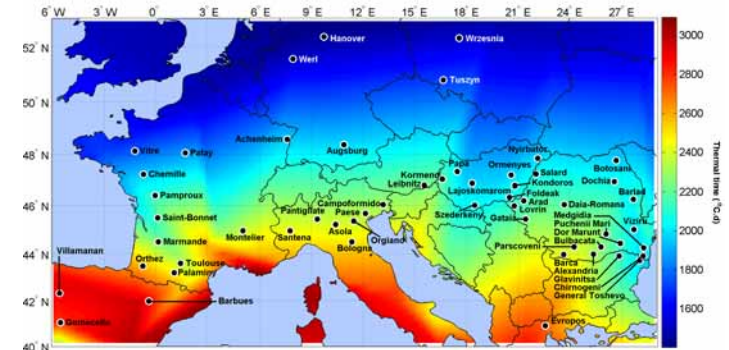
Disentangling complex traits



Genetic analysis of complex traits



Crop – climate optimisation

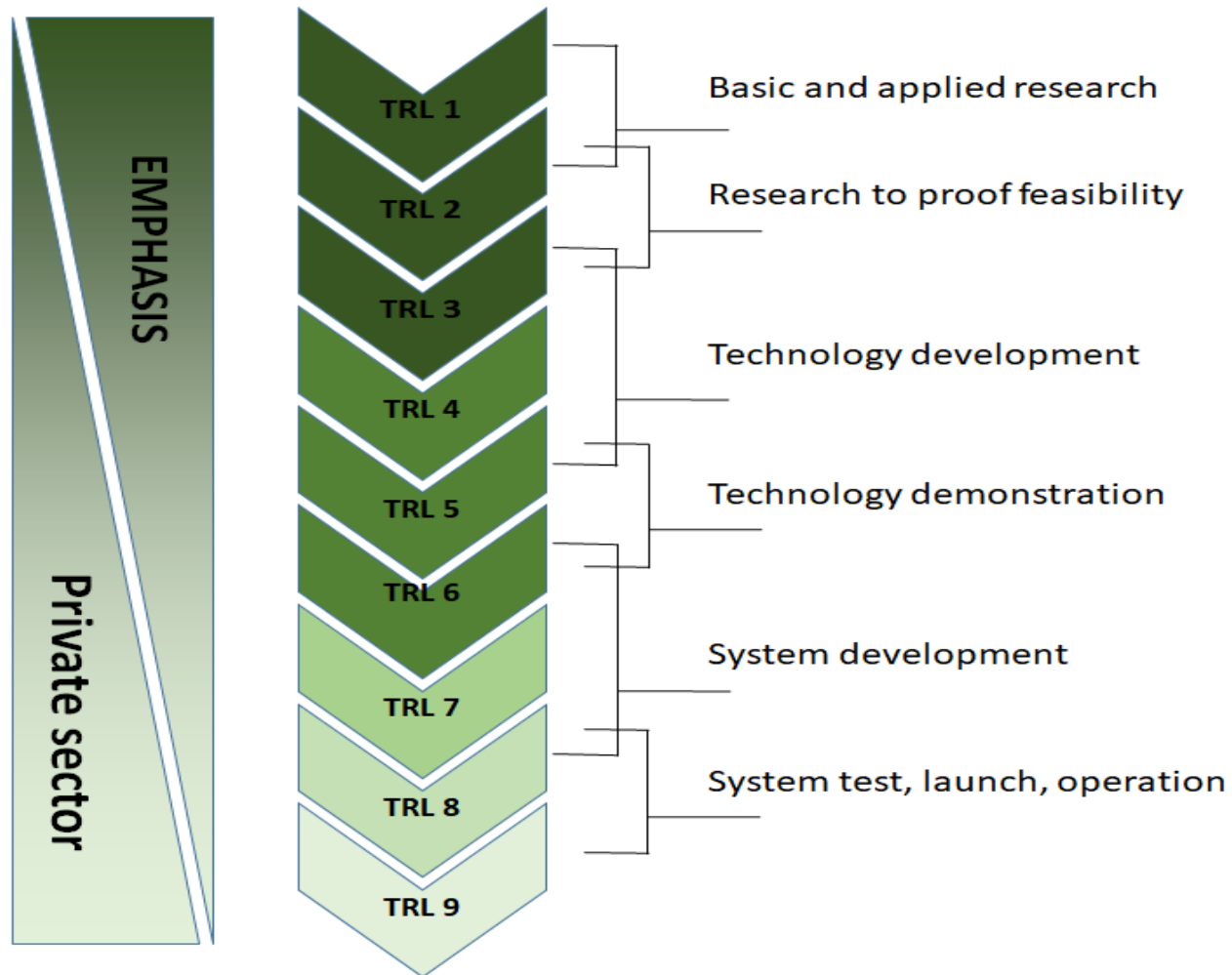




- Discovery (e.g. traits, markers, tools, methods etc.)
- Proof of concept Experiments
- Validation in relevant conditions
- Pre-breeding to combine discoveries with other beneficial traits
- Breeding – compiling traits in elite germplasm to create new lines
- Field trials of elite new lines
- Seed multiplication and purification
- Distributing and marketing of improved lines
- Production o farmers field

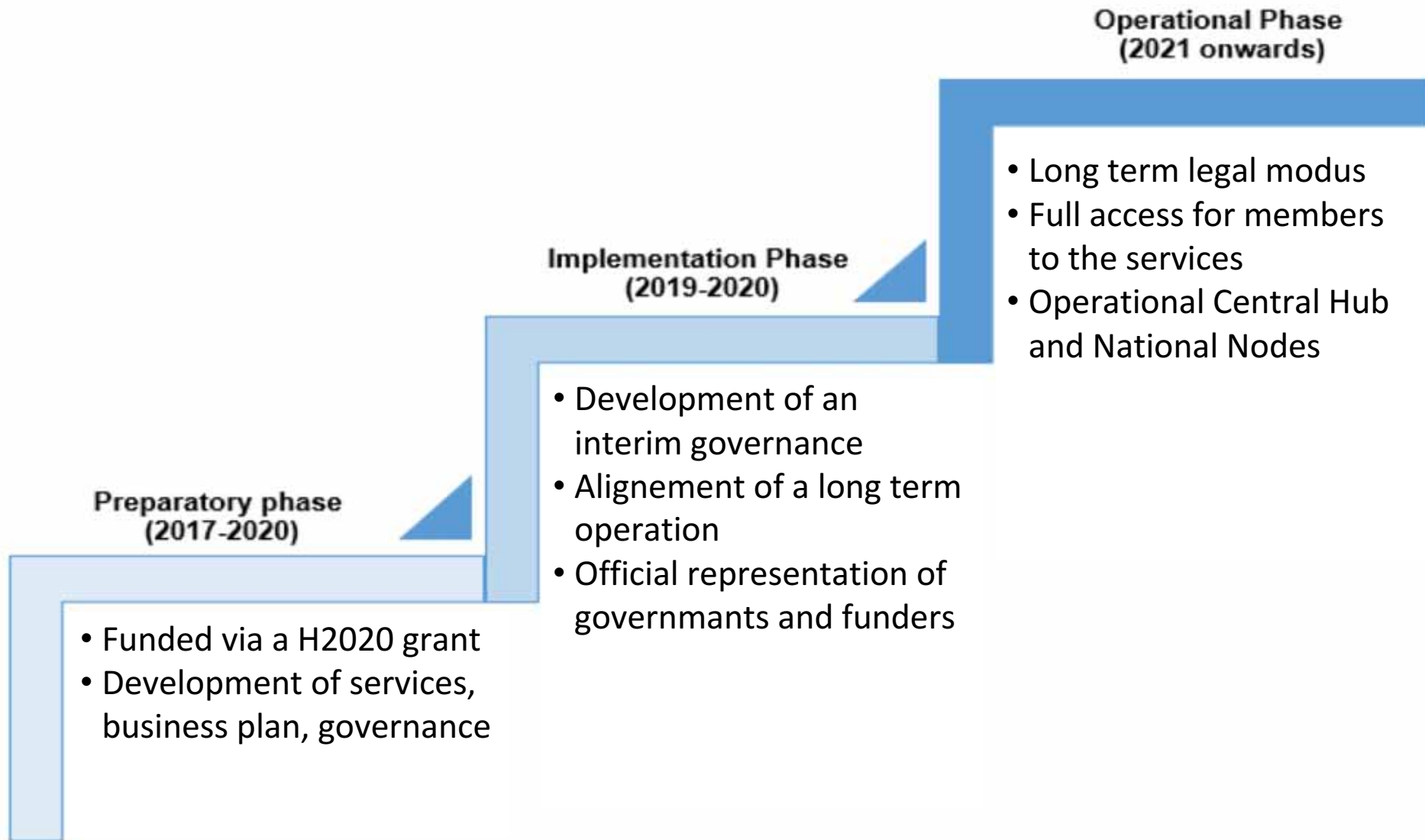
EMPHASIS innovation

ESFRI



EMPHASIS governance evolution

ESFRI



European Plant Phenotyping Network Projects

3rd call for access - mid-September 2018



2017-2021

Access to 31 installations in Europe

1st & 2nd call (preliminary results):

- 63 Applications were submitted
- ~55 projects are in progress

<https://eppn2020.plant-phenotyping.eu/>



Based on a simple application procedure



Calls every 6 months



Full cost of projects covered by the project, including travels

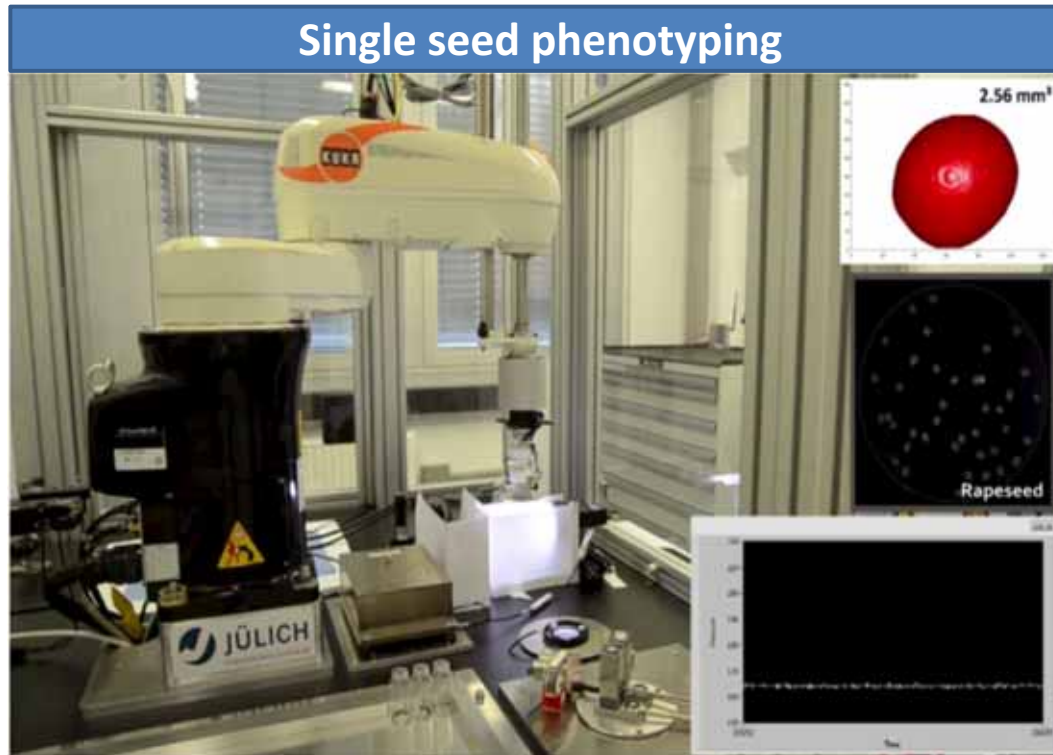


20% accesses for non-European

Rapid development in plant phenotyping

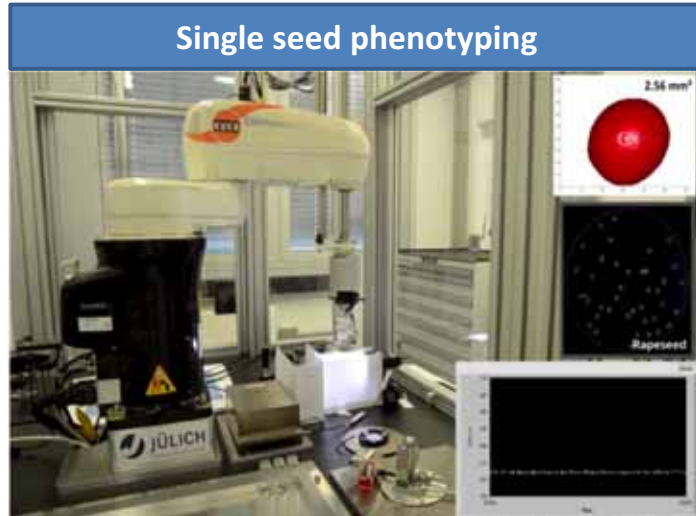
Rapid development in plant phenotyping

Single seed phenotyping



Rapid development in plant phenotyping

Single seed phenotyping

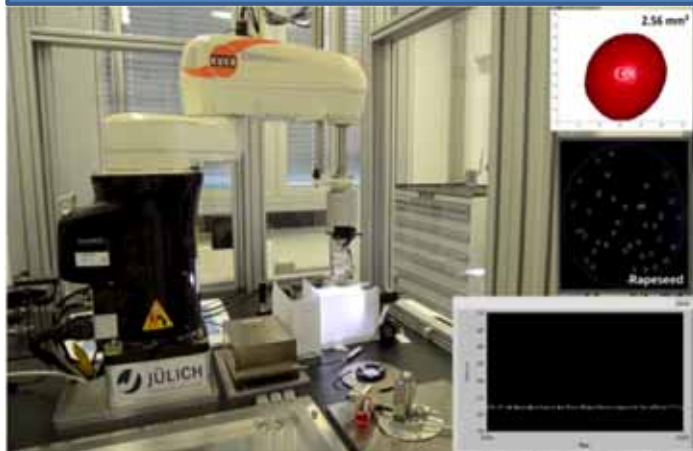


Automated cultivation / Trait assessment



Rapid development in plant phenotyping

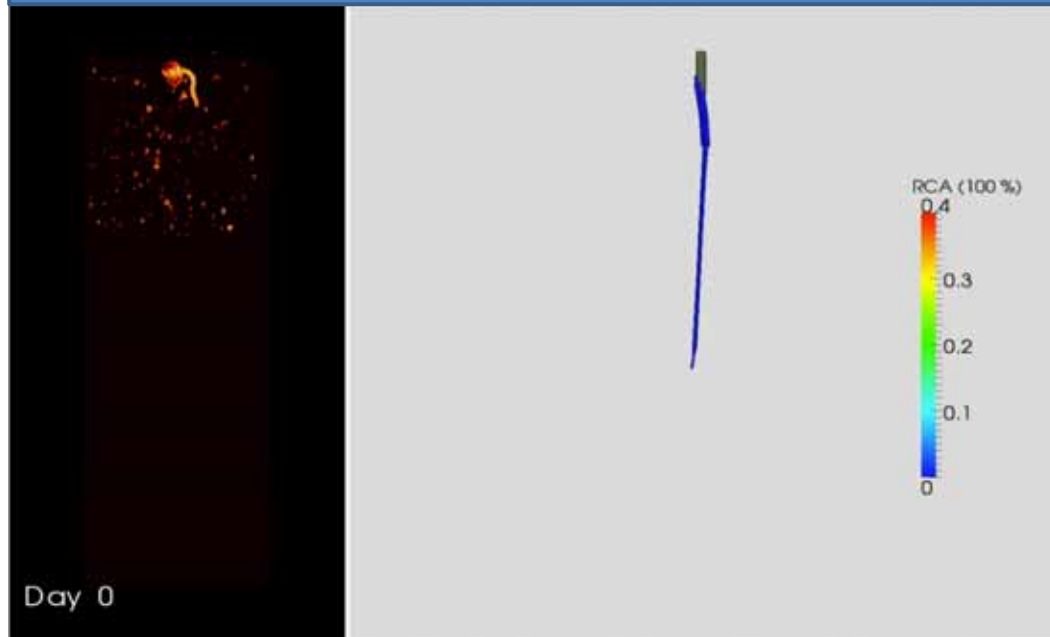
Single seed phenotyping



Automated cultivation / Trait assessment

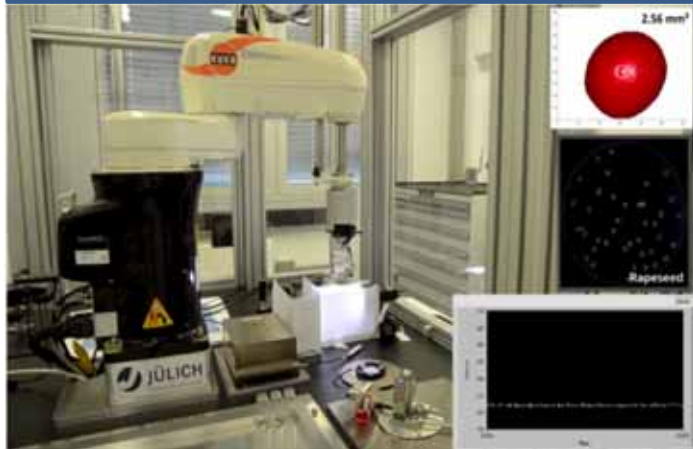


Data analysis and modelling



Rapid development in plant phenotyping

Single seed phenotyping



Automated cultivation / Trait assessment



Data analysis and modelling



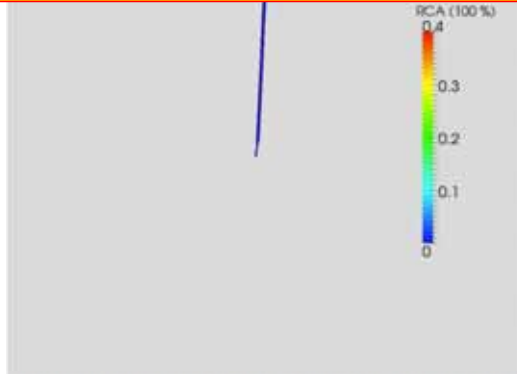
Across scales: lab to field



Rapid development in plant phenotyping

Phenotyping is a tool

- *Addressing diverse traits with the relevant equipment*
- *Integration into the workflow*



Largest challenges in plant phenotyping

Need to Network

- *Balance infrastructure development and user demand*
- *Develop, apply and disseminate infrastructure*