European Infrastructure: Multi-scale Plant Phenomics and Simulation for Food Security in a Changing Climate

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Phenotyping is a bottleneck

Key Messages

- Plant phenotyping has become a bottleneck in basic plant science and plant breeding
- Novel opportunities for phenotyping develop from interdisciplinary approaches of plant scientists, (bio)informatics, sensors and environmental sciences and simulation.
- Phenotyping needs to integrate activities for establishing mechanistic, high-throughput and field-based platforms
- Europe has a very strong position in plant phenotyping
Plant phenotyping does develop dynamically (Inter)national projects and networks
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European Plant Phenotyping Network

Goals

• Transnational Access (TA)
• Integrative Research Topics (IT, Standards, Sensors)
• Networking and Dissemination
State-of-the-Art Phenotyping

Deep phenotyping - tomographic

Root parameters

Plant MRI-PET Center, Jülich

$^{11}\text{CO}_2$

Live imaging of carbon flow

MRI (4.7T)

PlanTIS (PET)

Reconstruction

Reconstruction

Hounsfield micro-CT, Nottingham

3D-structures
State-of-the-Art Phenotyping

High-throughput in controlled environment

Fluogrowscreen Jülich

Petri-dishes Carousel
Root / Shoot evaluation

Root Carousel Jülich
State-of-the-Art Phenotyping

PhenoArch, Montpellier

GrowScreenRhizo, Jülich

Lemnatec, Aberystwyth

Extended Lemnatec, Gatersleben

High-throughput in controlled environment

PPHD, Dijon
State-of-the-Art Phenotyping

Intensive field sites
highly equipped

Phenomobiles

Mobile Shelters
Clermont

BreedFace
Jülich/ Bonn

Avignon
Jülich
....

Stationary field sensor networks

Flying platforms
State-of-the-Art Phenotyping

Breeders field lean equipment

Portable sensors („cheap“)

Easy carriers

Flying platforms
State-of-the-Art Phenotyping

Disentangling complex traits
Genetic analysis of complex traits
Crop – climate optimisation

What is the relationship between root structure and nutrient use efficiency?

What is the sensitivity of leaf growth to drought?

Which genotype would work best in which environment scenario?
Phenotyping – in Networks

National platforms

European projects/networks

International networks
Plant Phenotyping Survey:

197 participants from 38 countries

Some results

Is there enough capacity?

- I don’t know
- NO
- YES

What is the next challenge?

- Data management
- Field phenotyping
- Technological limitations
Phenotyping – in Networks

National platforms

European projects/networks

European Infrastructure

European Infrastructure for Multi-Site Plant Phenotyping And Simulation for Food Security in a Chancing Climate
ESFRI at a glance

European Strategy Forum on Research Infrastructures

mandate:

• To support a coherent and strategy-led approach to policy-making on research infrastructures in Europe;
• To facilitate multilateral initiatives leading to a better use and development of research infrastructures.

Organisation in Strategy Working Groups (SWG) on major challenges

• Energy
• Environment
• Health and Food
• Social and Cultural Innovation
• Physical Sciences and Engineering
EMPHASIS partnership

Proposers of EMPHASIS (March 2015)

• Government: DE, BE, FR and UK

• Research: DE: Forschungszentrum Jülich
  DE: Helmholtzzentrum München
  DE: IPK Gatersleben
  BE: VIB, Ghent U
  BE: UC Louvain
  BE: Gembloux Agro-Bio Tech
  BE: U Liège
  BE: ILVO - Institute for Agricultural and Fisheries.
  FR: INRA (with 5 different research nodes)
  FR: CEA.
  FR: Arvalis Institut du Végétal
  FR: Terre Innovia
  UK: National Plant Phenomics Centre, Aberystwyth)
  UK: U Nottingham
EMPHASIS support

Associate partner strategy
- Expression of interest to be involved in further developments
- Focus on national platforms/ representation

Status 14/09/2015 – based on letters of intent
- Government: NL (Gelderland)(18 Mio), CZ, CY, RO, SK
- Research: CH: ETH Zürich; Agroscope
  CZ: Hana – Center for Biotechnology and Agri Res.
  DE: Julius-Kühn Institute, U Bonn
  DK: Aarhus U; Copenhagen U
  HU: Hungarian Academy of Sciences
  IE: U Dublin
  IT: CNR – Consiglio Nazionale dele Recherche
  NL: Wageningen U
  PL: Polish Academy of Sciences (Plant Genetics)
  PT: Phenoplant-PT
  RS: NS-SEME: Institute of Field and Vegetable Crops
  SE: Swedish U of Agricultural Sciences
  SK: Slovak U of Agriculture
  UK: U Edinburgh, John Innes, Rothamsted, NIAB

All associate partner at least with in-kind contributions
EMPHASIS support

Status (14/09/2015)
• Companies
  Agri-Industry
  Bayer CS, BASF PS
  Limagrain, Biogemma
  KWS, Syngenta, RAGT
  Sesvanderhave, Plantum

• Technology
  Lemnatec, PhenosPex
  PSI, Elcom + SMEs

• International Organisations
  • CGIAR
  • EMBL-EBI
  • Australian Plant Phenotyping Facility (APPF)
  • COST Action FA1306
  • ERA-NET COST

EMPHASIS is open for additional partners
EMPHASIS infrastructures

Phenotyping platforms for high resolution, high throughput phenomics

Semi-controlled field systems for high throughput phenomics

Network of practical field experiments for lean-phenotyping

Modelling for improving phenotypic processes and for testing existing or virtual combinations of alleles in a variety of climatic scenarios and management practices

Joint data management and e-infrastructure
## EMPHASIS access modes

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<th>ACCESS Mode</th>
<th>Purpose</th>
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| Internal Development Access (IDA) | • exchange of knowledge  
                                | • technology transfer                                                 |
| External Development ACCESS (EDA) | • test of new equipment from external groups (incl. industry)           |
| Use ACCESS (UA)             | • providing infrastructure to study GxMxE  
                                | • state-of-the-art technologies  
                                | • specialised technology (e.g. tomography, modelling)                  |
| Dissemination ACCESS (DA)   | • learning/ training in phenotyping centres  
                                | • learning about new technologies and modelling                       |

All these modes are successfully addressed in national nodes
EMPHASIS – why going European?

- Generating synergies between national platforms
  - Special equipment
  - Data management
  - Joint protocols/exchange – interoperability
  - Education and training
  - Outreach

- Access
  - Development access
  - Use access
  - Dissemination access

- Generating novel opportunities
  - Unique installations
  - Diverse climate zones
  - Interaction of academia and industry across Europe
EMPHASIS – what’s next?

• Political decision by ESFRI forum (expected in December)

• Development and „maturation“ of further national platforms

• Maturation of the organisation -> preparatory phase

• Expansion of the partnership from member states
  • Governments of ESFRI member states
  • Research Organisation
  • Industry

• With resources (cash of in-kind)
• Letters of interest

• Associate status for countries, research organisations and industry
University of Copenhagen and Aarhus University are pleased to announce the 2nd annual meeting in COST Action PhenomenAll Copenhagen April 18-20, 2016

2nd general COST MEETING

18\textsuperscript{th} - 20\textsuperscript{th} of April 2016

Copenhagen, Denmark

The second general meeting of COST action FA1306 "The quest for tolerant varieties - Phenotyping at plant and cellular level" will take place at the University of Copenhagen.

Important Dates:

Start of online registration: 2 November 2015

31 January 2016: Deadline for submission of abstract

31 March 2016: Final registration for the conference

18-20 April 2016: Conference
For more info look at:

http://www.plant-phenotyping.org/home_of_2nd_meeting

Abstracts that follow the Abstract Template should be submitted via the registration page, link found on the homepage.

For questions concerning the conference, please contact Info.PhenomenAll2016@food.au.dk.

Eva Rosenqvist, UCPH (convener)
Carl-Otto Ottosen, AU (co-convener)
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