EMPHASIS Field Phenomics workshop

ILVO | Thursday 06-September-2018

Report:
October 2018
M. Morisse, S. Fahrner, R. Traini, D. Wells

EMPHASIS-members participated in the workshop:
S. Fahrner, R. Pieruschka, S. Dhondt, R. Traini, D. Wells, M. Morisse

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Outline of the workshop

How will the future of Field phenotyping in (pan-)Europe look like?

This was THE topic of the EMPHASIS Field Phenomics workshop on the 7th of September 2018. Scientists involved in field phenotyping, from both industry and academia, discussed this during the workshop. In total 68 people participated. The day started with a bus ride to the ILVO site, in Melle, just outside of Ghent. We had a welcome word from the head of the ILVO plant department, Isabel Roldan-Ruiz, followed by an introduction to the EMPHASIS-PREP project by Roland Pieruschka. Onno Muller of the Jülich Research Centre (FZJ) gave a keynote speech about field phenotyping, a combination of personal ideas on the future of field phenotyping and insights on the current developments in FJZ concerning field phenotyping. After a small break the group was provided with a field visit at the ILVO site, divided into 5 topics: ECOFE, Oilseed rape project, Rain-out shelter visit, drone demo and field data modelling. For more information about the complete agenda of the day information can be found in annex 1. After lunch we continued the workshop with breakout sessions on the future of field phenotyping in Europe. This was done in two smaller groups of about 30 people, to simplify the discussions, and used the online system 'Mentimeter' was used as a way of stimulating the discussions and helping to express their ideas. The details about the breakout sessions will be discussed below.

Breakout sessions results

During the Breakout sessions the Mentimeter tool was used, where participants could provide an answer on the spot via their smartphone or laptop. The questions were the same for both groups of breakout sessions.

Question 1: Where do you Work?

The first question provided us insight into what people were present in the discussion. 64% of them came out of academia whereas 36% came out of companies.

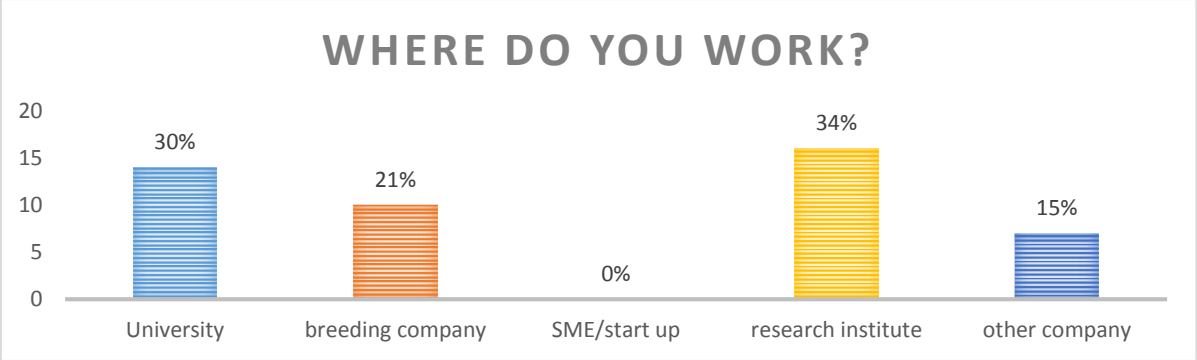


Figure 1: Combined results of both discussion-groups on the questions where do you work.

Questions 2: What makes a good field experiment?

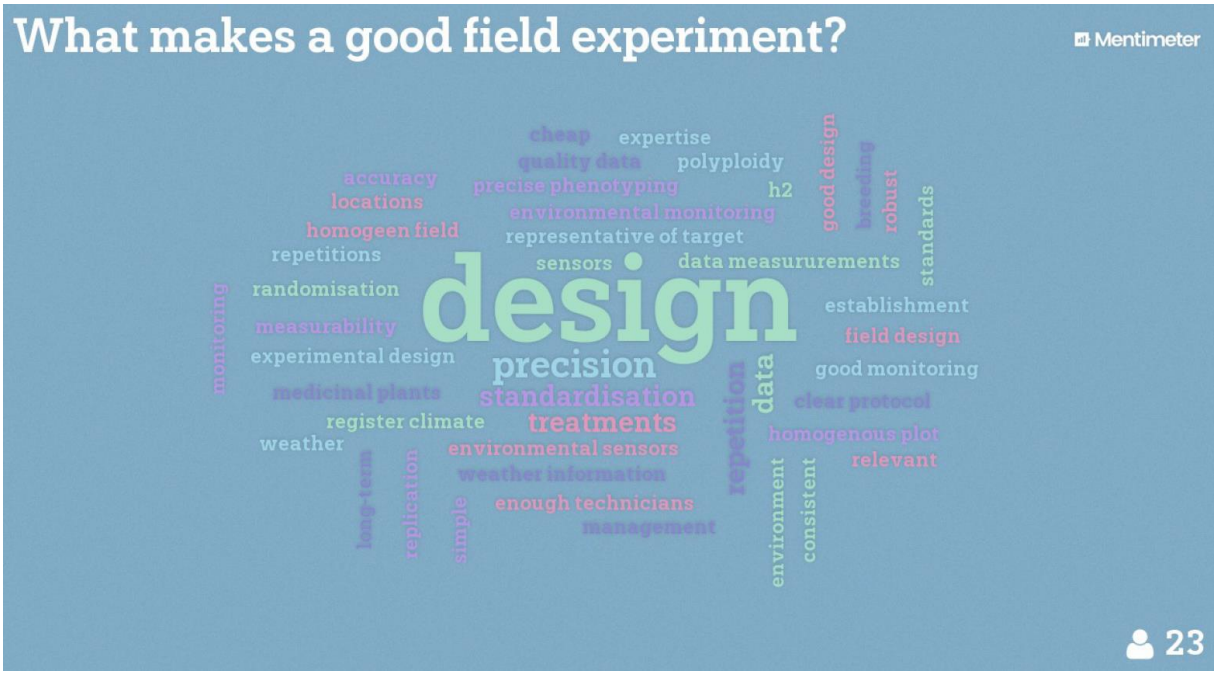


Figure 2: word cloud of group 1 to the question "what makes a good field experiment?"

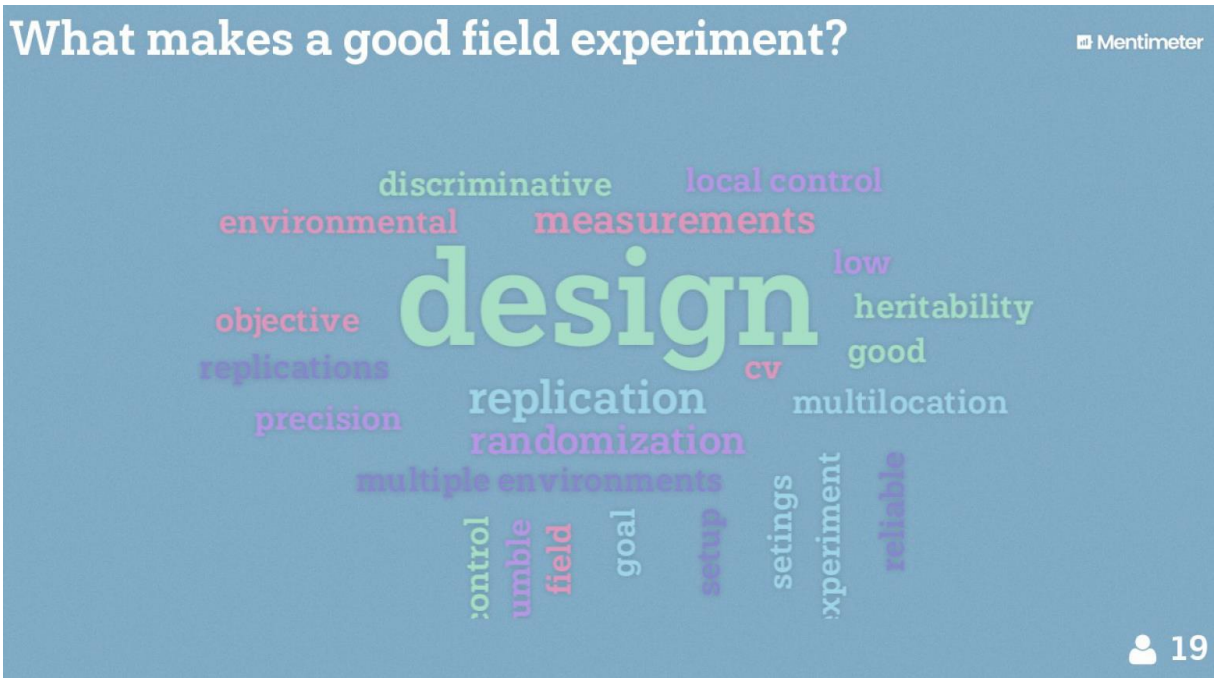


Figure 3: word cloud of group 2 to the question "what makes a good field experiment?"

Discussion:

- For both groups a good experimental DESIGN seemed to be most essential for a good field experiment (see figure 2 and 3). Also ENVIRONMENTAL MONITORING seems very important for field experiments.
- There was a discussion on the word “Cheap”, more specific on the costs of field phenotyping. There seemed to be different perspectives between academia and industry on the cost of field experiments - tooling up costs are high to start with, as things progress costs reduce and throughput increases. Some participants added that costs need to be evaluated in the context of created benefits.
- Standardization was a point of agreement - this is important as generally different labs / researchers have typically done things differently. Standardization in that context means enabling interoperability, but not necessarily doing exactly the same. Interoperability is the key - not everything has to be the identical as long as the data is interoperable - there should still be freedom

Questions 3: What are the strengths of field phenotyping in Europe?

Responses group 1
Climatic diversity
Diverse environments
Availability of infrastructure and providers
Environmental diversity
Connection with research institutes
Connectivity
Extreme climate
Pedoclimatic diversity

Technology Innovative tools Connection with research Clear targets per mega environment Collaborations Diversity but not that far away Technology - key phenotyping companies are in the EU

Responses group 2 Advanced technology Access Communication Technologies Quality Collaborations Easy exchanges Close Technology Same crops Many partnerships Explore large range of scenarios *Diverse* Technologies Collaboration diverse knowledge Networking dedicated phenotyping systems environmental monitoring Plant materiał exchanges

Discussions:

- Common theme was around ENVIRONMENTAL DIVERSITY - though is this specific to Europe? Are there more differences in Europe than say the USA? However, this diversity is considered an opportunity in terms of new trials, not being taken account of sufficiently.
- Europe seem to be very good in technology and innovation.
- Connections between Research & industry - beneficial relationship that elevates both sides - maybe helped by geography and ease of collaboration?
- There are also strong collaborations between EU ROs / Universities

Questions 4: Do we need a minimal (European) standards for field phenotyping? And what would be the benefits for you?

Responses group 1 Yes. To be able to make comparisons No Comparability Open data Clearly yes

Follow MIAPPE. Standardization will help ensure data is useable for longer.
Yes. Easier to interpret data and compare results.
Yes, assure quality of results
Database toolbox
Allows for a central repository of minable data to prevent repetition and aid model development
Yes! Combination of data and better prediction
Sharing knowledge
Yes, ability to reuse data
Standards may make results more comparable

Responses group 2
facilitate multi-environment analysis
Yes, mandatory at least the way experiments and experiments are described: needs at least ontology
No
"Yes
Benefit for the scientist, able to link own data with those of others"
"Adopt ontology
Make multi environment or meta-analysis doable"
Yes, different levels of SOP certifications may increase comparability
clarity on the methods rather than standards
Minimal definition of what are standards :)
1 standard per project?
Benefit when same genotypes are planted in several countries"

Discussions:

- In both groups the majority agreed upon the need of STANDARDIZATION in field phenotyping methods and data, to be able to easier interpret data and compare result. Nevertheless, there were some that that had concerns that standards would become obligatory. EMPHASIS will have a supportive role, moderating the process towards joint standards to be developed by the community itself.
- There were different opinions about standardization between academia and industry. Were industry seemed to be less interested in adapting their experiments towards different standards, academia was more open for this e.g. in a context of open science, comparing their research results with other similar experiments and interoperable data as tool for development of models.
- The need for any standardization to be regularly reviewed was discussed, with the concept of continuous development and community engagement to ensure relevance.

Question 5: What would be a good approach for field testing for important traits addressing global challenges like climate change and food security?

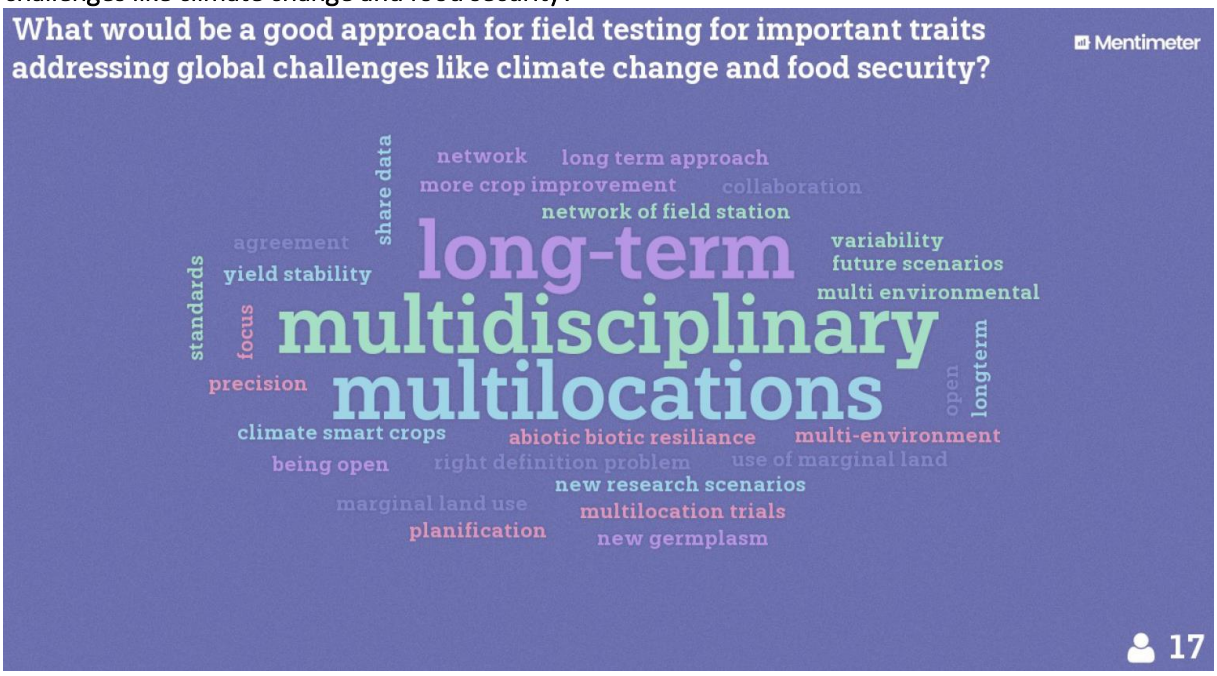


Figure 4: word cloud of group 1

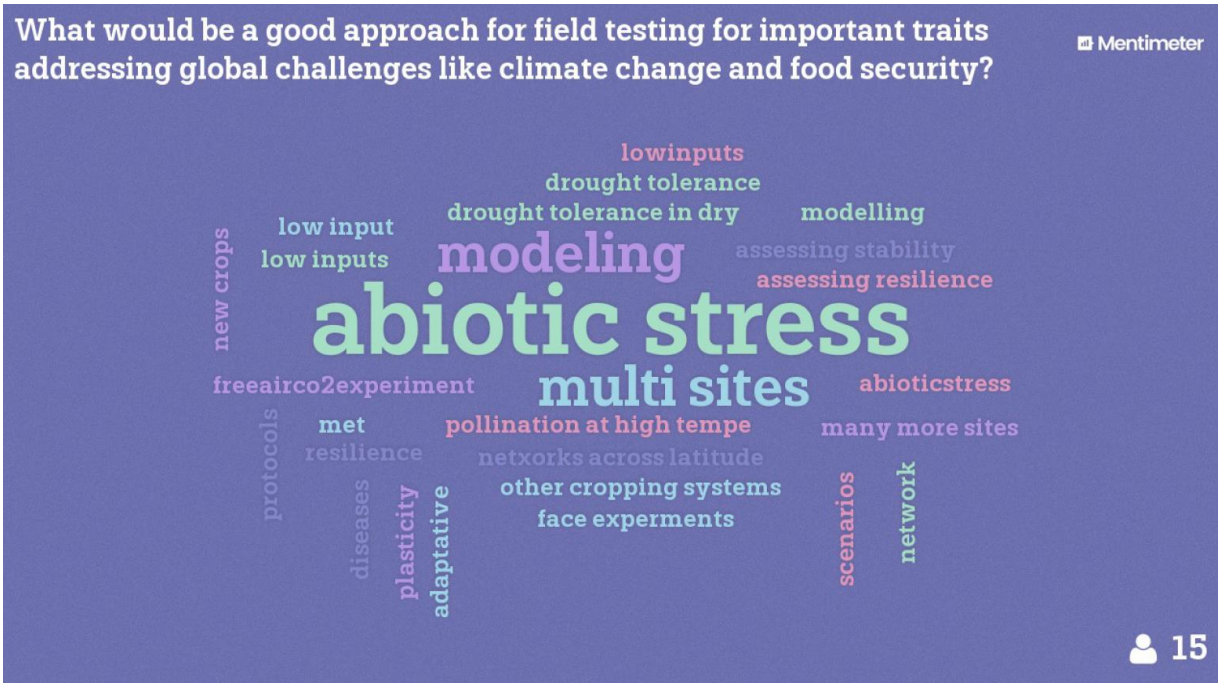


Figure 5: word cloud of group 2

Discussion:

- Multisite or multilocation field trials was one of the major ideas on tacking the global major challenges. Crop performance is different in different climatic regions in Europe. Lots of focus was also on terms around collaboration - multidisciplinary / multi-location / long-term. Only by bundling all strengths these major challenges can be tackled.

- Others stated that abiotic stress should be the major focus in tackling these global challenges.
- Some researchers from Australia stated that they have lots of marginal land. The discussion continued on the questions if we can make better use of marginal land, potentially looking at how climate change may influence growth environments or how to make better use of marginal land for non-food crops.

Questions 6: How can a multi-site experiment over multiple years (in different climatic environments) been organized in the future?

Responses group 1
Commitment and leadership money Good coordination To point research question "Fluent communication. Good protocols." Good management By EMPHASIS Good design and collaboration Pacification, analyze the data, quality checking and revisit the environments Pilot study to determine best management practices and minimum standards - controls and phenotyping. Strong reporting standards Frequent communication Standardization leading to open science/data

Responses group 2
Well Look at the past Have specialist in organizing. Not scientists Similar designs. Different randomizations. Analyze per site before global. With interdisciplinary expertise Does it have to be an exact repeat? "Same standards and Measure of all environmental conditions" Characterize and choose your environments in advance "Collaboration with famers. Define target of population environments (TPE) better. Connectedness between trial sites and years." "Define scenarios ecological zonation Characterize the scenario experience by plant" Project should be in long term. Or data should be stored to be used in future.

Discussion:

- It was stated that CENTRAL CONTINUED SUPPORT (both management / potential funding) is needed to form a multisite field trials. Management and organizing of this should be done by specialists, not scientists.
    - Ensure joined up planning of experiments
    - Ensure continuity of experiments across multiple years
- Multi field site experiments need to be done by standardized experiments, but we need buy in from local collaborators.
    - Data from all sites needs to be standardized and easily accessible to all collaborators - build a *common IT platform*
- Money is needed to this - engaging with industry, end users are not just breeding companies…
    - Potato - companies producing fires / wheat - milling companies: have preferences for different traits in crops

Question 7: How to obtain comparability/interoperability in multi field trials?

Responses group 1
Standards Standardization Clear protocols expert working groups Standards protocols Common protocols and one management SOP Standards Yes indeed standards Reporting standards and robust calibration methods Standards in methods and good design Statistics

Responses of group 2
Agree on ontology "Mobility Some standards"

Discussion:

- Interoperability and comparability in field phenotyping would be obtained by standards, common protocols like standard operating procedures (SOP's) and calibration methods, which need to be managed by expert groups united in one major management.

Question 8: What is your opinion on sharing (raw) field data?

Responses group 1
Yes yes

Good for advancements in analysis methods
Open Science
Definitely needed internally, perhaps just detail methods externally
Both academia and industry should share
Complex to organize #standards
Define "RAW" - Some type of data cleaning, outlier removal might be useful
Good for multidisciplinary approaches
part of the commitment but should come with methods for a sound analysis
Difficult for the industry
Most useful with pedigree data, which is often commercially sensitive. If variety released but pedigree can be withheld, then raw data can/should be shared
Needed to compare data, analysis trends or timelines and apply different techniques on those data

Responses group 2

Can it be coded/anonymous?
Interesting but we need that data generated on a site be expertise by the key person from the field
"Often difficult except if well documented
Very important to some methods based on machine learning"
Yes with environmental conditions. What about access to genotypes?
All for it, of course anonymized if needed and well documented
Opinion is different between level of data from raw to fully analyzed/published
Data from public research should be shared as long as stakeholders agree. Later, new technology may become available, then raw data might be analyzed again.
Yes, but should be a return to the provider

Discussion:

- Concerns from representatives from industry regarding sharing of commercially-sensitive data. Companies are understandably risk-adverse and even with anonymized data are unlikely to share results with potential competitors.

Question 9: What criteria of field phenotyping installations should be included in EMPHASIS?

Responses group 1

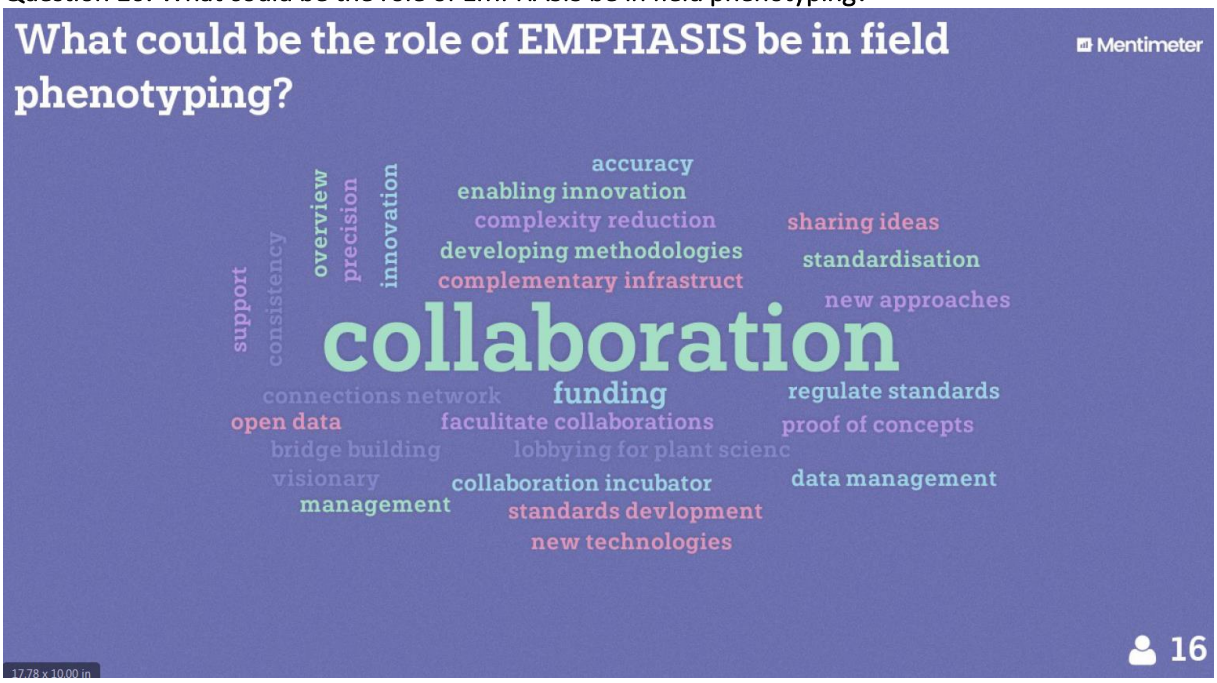
Start with current best practice and innovative approaches that deliver more and better information.
real crop production environments
All environmental conditions, high throughput, good design
At least relatable to commercial growing conditions
"Semi-to high throughout
Connectivity
Power
Equipment robust, able to be function in harsh environments, transportable...,"
Detailed environmental monitoring, cutting edge digital technology, scalability from exploratory to large scale
should deliver useful trait information in relative short time
Field experience
Minimum size, good experimental design

Well characterized site(-s) with relevant equipment allowing high throughput More focus on the data analysis and speeding up the analysis "Multi-sensors Acquisition standardization Interoperability High throughput Collaboration with variety evaluation sector"

Discussion:

- EMPHASIS should focus on high-throughput experiments, potentially look to have a minimum size of experiments?
    - How do we define minimum size?
- Relatable to commercial conditions - is the design of our experiment appropriate for the questions we are looking to address?

Question 10: What could be the role of EMPHASIS be in field phenotyping?



Discussion:

- There was a common understanding that EMPHASIS should focus on mostly facilitating COLLABORATION between researchers. Collaboration that generates data that we can all trust. But also standardization, innovation and funding where topics that were put forward as services for EMPHASIS.
- Positive reaction to the idea of EMPHASIS providing a service for TESTING NEW TECHNOLOGIES and ACCESS TO MOBILE EQUIPMENT.
    - Would be good as EMPHASIS can be independent "no hard sell of technology"
- Increase awareness of current infrastructure and expertise

Question 11: How could EMPHASIS facilitate to reach common standards across institutes?

Responses group 1
Publications - workshops - education Provide information on the facilities as well as expertise at those facilities Build further on ECOFE...

Responses group 2
Trainings Expert working group Expert group that works via an iterative process with many feedback moments

Discussion:

- A role for EMPHASIS was foreseen in setting and training users in best practices, overseen by expert working groups drawn from stakeholders.

Question 12: How can EMPHASIS form a network of field trials?

Responses group 1
Reciprocal engagement and funding Clear objectives Take contact with existing company having a network By starting with a successful pilot project. Get interested parties together and design trials Invite members, talk to people about the benefit of This, show examples, show the win-win, provide funding and guidance Build one data infrastructure Look for mutual/symbiotic interests Provide details of both the network of facilities as well as the expertise at those facilities build further on ECOFE Creating benefits - mutual interests

Discussion:

- The public had questions about: How does EMPHASIS advertise? How do we get the information out about what we are working on, what the expertise is?
- ONE DATA INFRASTRUCTURE is a need of this kind of network - though may not help to from?
- New tech in a new market - we should take a step by step approach - start smaller and do things well.

Question 13: What are the needs of the field phenotyping community towards a legal entity of EMPHASIS? What (pilot)services do you think EMPHASIS needs to have?

Responses group 2
Find partners. Tinder for phenotypers Coordinate multi-site & multi climate trials. Share knowledge about phenotyping devices. Relevant choice of traits by crop, measured at the right time (help of crop models?), with environmental relevant variables "Provide ontology Possibly share data from raw to traits Provide pipelines for data processing Organize benchmarking of methods" Maintain interaction

Question 14: How can access to field trails been organized?

Responses group 2
Consider a cost model First come first served Consider also moving instruments to fields Access to mobile equipment? How can EMPHASIS be a benefit for both industry and academia?

Question 15: What role can companies have in EMPHASIS? What are the demands of companies towards EMPHASIS?

Responses group 2
More business relevant measurements Channeling information Organizing training sessions Access to sensors expertise etc. For industry to learn what to measure with what technology. Exchange raw data from private sector with expertise from public sector Are companies interested in innovation technology testing via EMPHASIS?

Discussion:

- The concept of limited but relevant (focused) phenotyping being of more benefit to industry was discussed.

ANNEX 1

Time	Item	Lead
8:50 9:00 9:30	Gather at the back of the Ghent St-Pieter railway station. Leave from Gent St-Pieters to ILVO + registration on the bus Arrival at Caritasstraat 39 (entrance)	Bus arrangement: Merlijn Morisse
9:30 9:35	Welcome and introduction to ILVO – Isabel Roldán-Ruiz Introduction of EMPHASIS	Isabel Roldán-Ruiz Merlijn Morisse
9:50	Key-note: Onno Muller, head of field phenotyping FJZ	Onno Muller
10:40	**Coffee and split in 2 groups.**	
10:55	**Field visit** Group in two groups - ECOFE poster (10') - Oilseed rape project (15') - Rain-out shelters and EUCLEG - soybean (15') - Drone based phenotyping + walk to ecofys lab1 (20') - Field data Modelling (15')	Marieke Louwers Sam de Meyer Aamir Saleem Peter Lootens Tom De Swaef
12:25	**Lunch and split in 2 groups.**	
13:15	**Break-out session on the future of Field Phenomics in (pan-)Europe and the role of EMPHASIS.** Key questions to address: - What makes a good field experiment? - What are the strengths of field phenotyping in Europe? - Do we need a minimal (European) standards for field phenotyping? And what would be the benefits for you? - What would be a good approach for field testing for important traits addressing global challenges like climate change and food security? - How can a multi-site experiment over multiple years (in different climatic environments) been organized in the future? - How to obtain comparability/interoperability in multi field trials? - What is your opinion on sharing (raw) field data? - What criteria of field phenotyping installations should be included in EMPHASIS?	Group 1 Moderator: D Wells Notes: S Farhner Group 2 Moderator: M Morisse Notes: R Traini

	- What could be the role of EMPHASIS be in field phenotyping? - How could EMPHASIS facilitate to reach common standards across institutes? - How can EMPHASIS form a network of field trials? - What are the needs of the field phenotyping community towards a legal entity of EMPHASIS? What (pilot)services do you think EMPHASIS needs to have? - How can access to field trails been organized? - How can EMPHASIS be a benefit for both industry and academia? - What roll can companies have in EMPHASIS? What are the demands of companies towards EMPHASIS? - Are companies interested in innovation technology testing via EMPHASIS?	
16:00	Bus back to Ghent St-Pieter railway station	