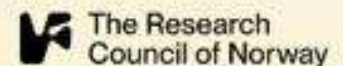


From Phenotyping Experiment to FAIR Data

11-13 March 2026 | Ås
NMBU, Norway



NBPPN



11th of March [Day 1]

Location: Innsikten, VET building

Morning (Hybrid, 9:00 – 12:00 CET)

Lectures:

8:30 – 9:00: *Welcome and coffee*

09:00-09:20: Introducing Nordic phenotyping infrastructures and networks

Morten Lillemo (PheNo, NMBU), Kristiina Himanen (NaPPI, UH), Svend Christensen (NBPPN, PhenoLab, UCPH), Xiang Su (NordPheno)

09:20-09:30: The Importance of Data Management in Plant Phenotyping – *Morten Lillemo (NMBU, NO)*

09:50-10:25: Data management benefit, common practice and potential tools – *Jesper Cairo Westergaard (University of Copenhagen, DK)*

10:25–10:40: *Coffee break*

10:40-11:25: The Road to Precision: Spectral Imaging for Abiotic Stress Responses—Are We There Yet? – *Sónia Negrão (University College Dublin, IE)*

11:30-12:00: Principles of handling UAV data – *Sahameh Shafiee (NMBU, NO)*

12th of March [Day 2]

Location: Innsikten, VET building

Morning (Hybrid, 8:45 – 12:00 CET)

Lectures:

8:30 – 8:45: *Welcome and coffee*

08:45-09:15: Making Data FAIR compliant – *Donald Hobern* (APPN, AU)

09:30-10:05: Image- based Phenotype of Fusarium head blight in barley and wheat –
Brian Steffenson (University of Minnesota, USA)

10:10–10:20: *Coffee break*

10:20-10:40: TraitFinder: 3D Multispectral Phenotyping for Plant Research – *Rita Armonienè* (LAMMC, LT)

10:40-11:10: Focus on PHIS main principles, architecture – *Farzaneh Kazemipour*
(INRAE, FR)

11:10-11:30: *Closing online session - Kahoot*



Making Data FAIR Compliant

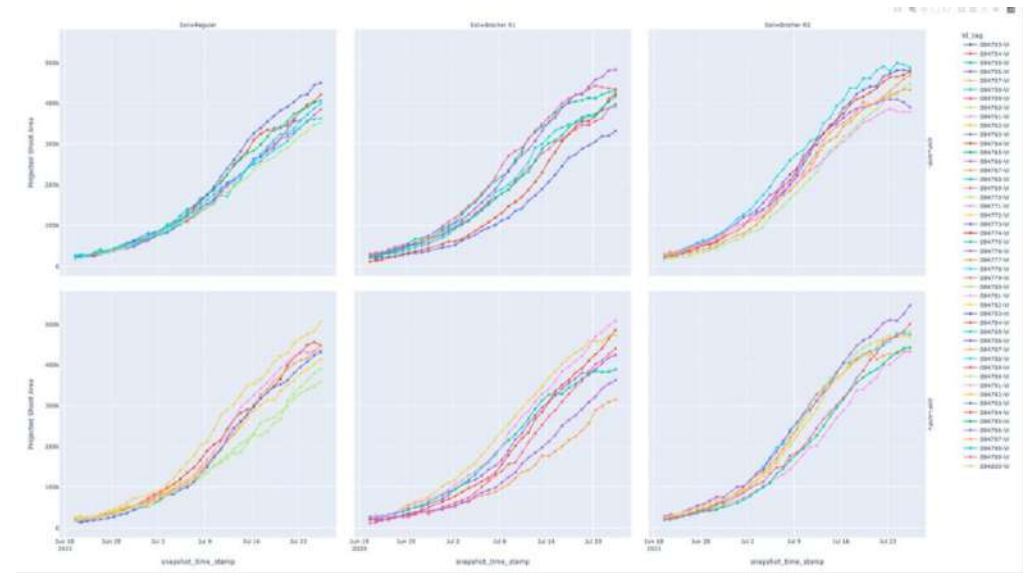
Donald Hobern
donald.hobern@adelaide.edu.au



appn
Australian Plant Phenomics Network

NCRIS
National Research
Infrastructure for Australia
An Australian Government Initiative

Plant Phenotyping






- Image-based measurement of plant traits
- Field and controlled-environment studies
- Time series trait data per plant/plot
- Associated environmental data
- Support variety development/selection
- Support optimal crop management

Australian Plant Phenomics Network



MAP KEY

Plant phenotyping capabilities

-  National suite of controlled environment facilities
-  Network of nationally coordinated field sites
-  Mobile phenotyping units to serve rural areas and field trials
-
- National Climate Observation Unit Network
-
- Collaborative Data Network

- National network
- Nine nodes
- Universities and state government
- Through major growing regions

Standardising data



- **WorldFAIR**
 - EU-funded with CODATA and RDA
 - Synthesis of 11 case studies
 - Improve FAIR implementation

Recommendation 1: Data Engineering

Policy makers and funders need to encourage and enable a data engineering approach in the data infrastructures that are the most important to address major societal and planetary challenges. Specifically, this requires supporting long lasting data aggregation and data integration services as part of EOSC and globally.

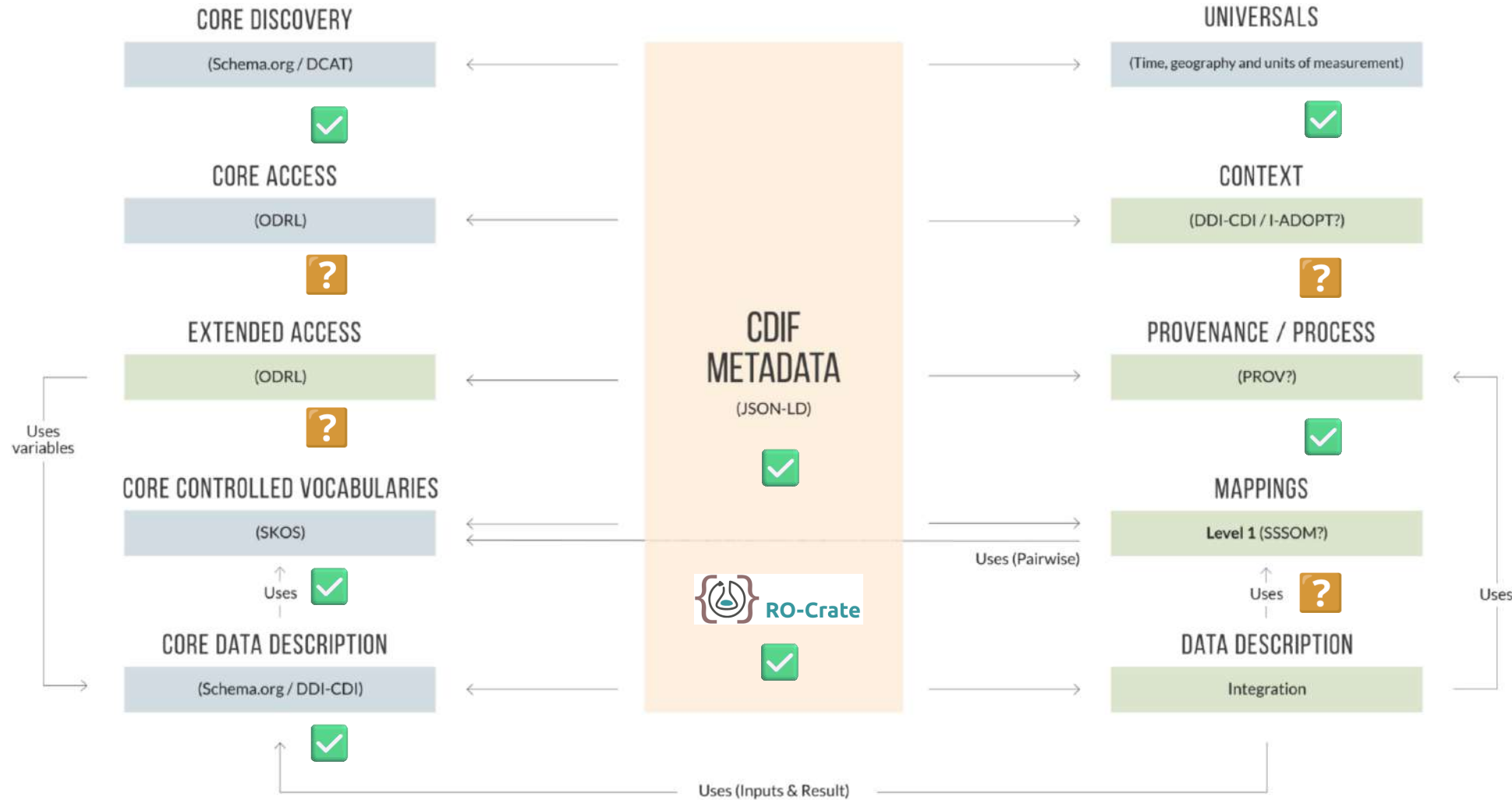
<https://doi.org/10.5281/zenodo.14236140>

Enabling Global FAIR Data: WorldFAIR Policy Recommendations for Research Infrastructures

This document presents the policy recommendations from the WorldFAIR project. It synthesises the project's findings and presents recommendations for specific stakeholders, for the European Open Science Cloud and other Research Infrastructures globally.

To meet the challenges and opportunities confronting 21st century science, including the need to support interdisciplinary research and the impact of AI, it calls for a shift to a data engineering approach and for investment in metadata uplift and the implementation of the FAIR principles to enable this.

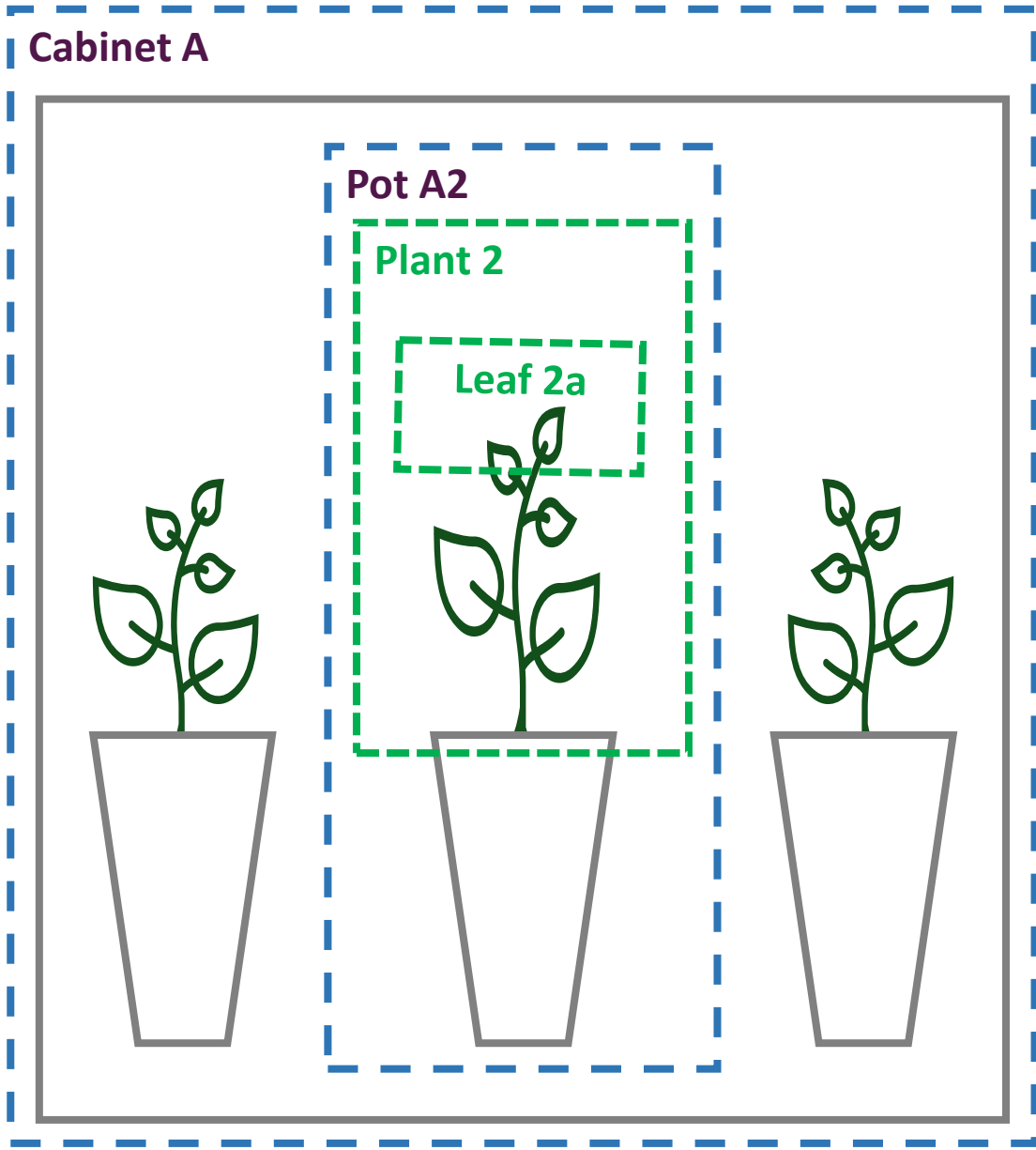
Cross Domain Interoperability Framework



<https://doi.org/10.5281/zenodo.11236871>



Observation unit hierarchies for controlled environments



Entities

Environments

- Cabinet A
- Pot A1
- Pot A2
- Pot A3

Biological Material

- Plant 1
- Plant 2
 - Leaf 2a
- Plant 3

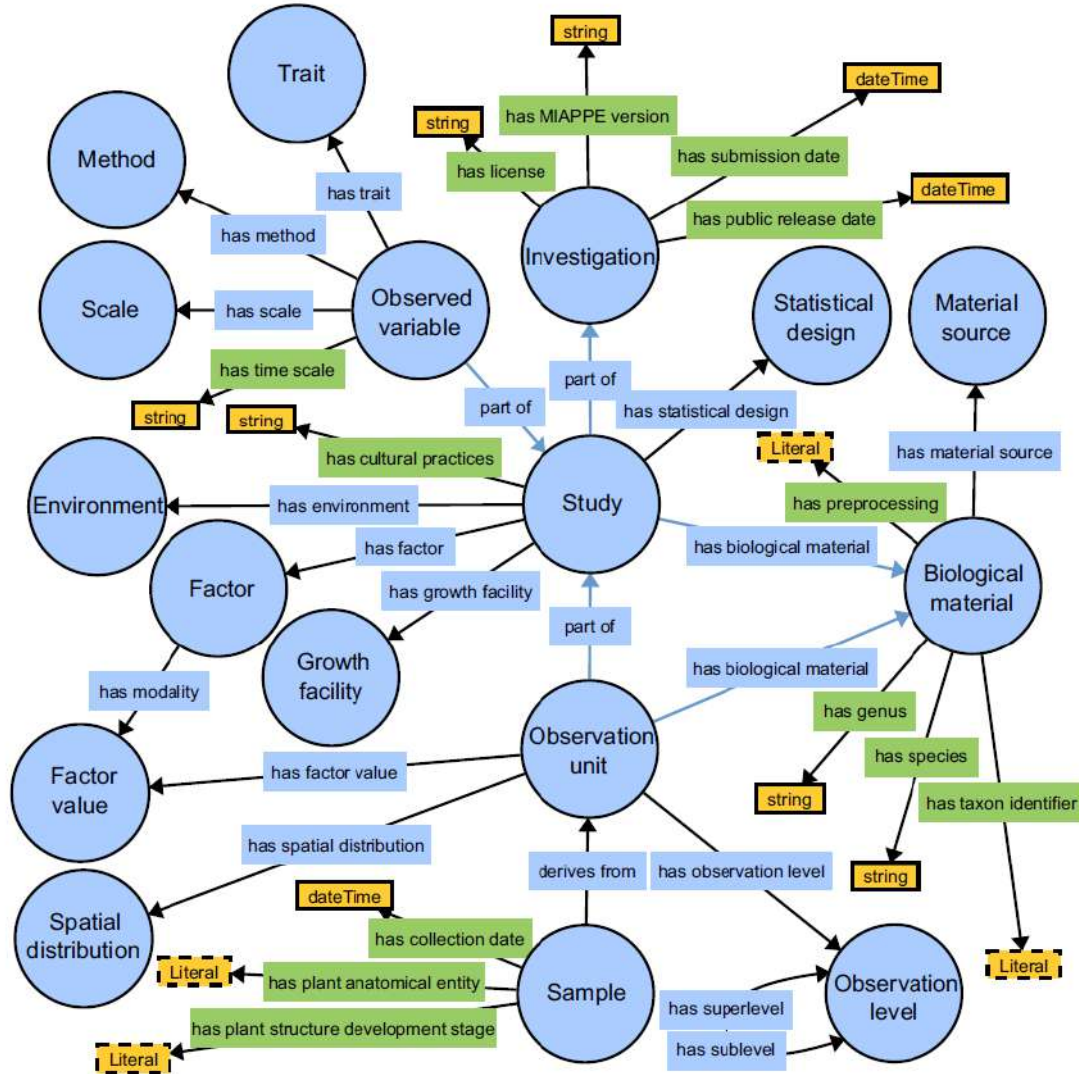
Hierarchy

Cabinet A > Pot A2 > Plant 2 > Leaf 2a

Data

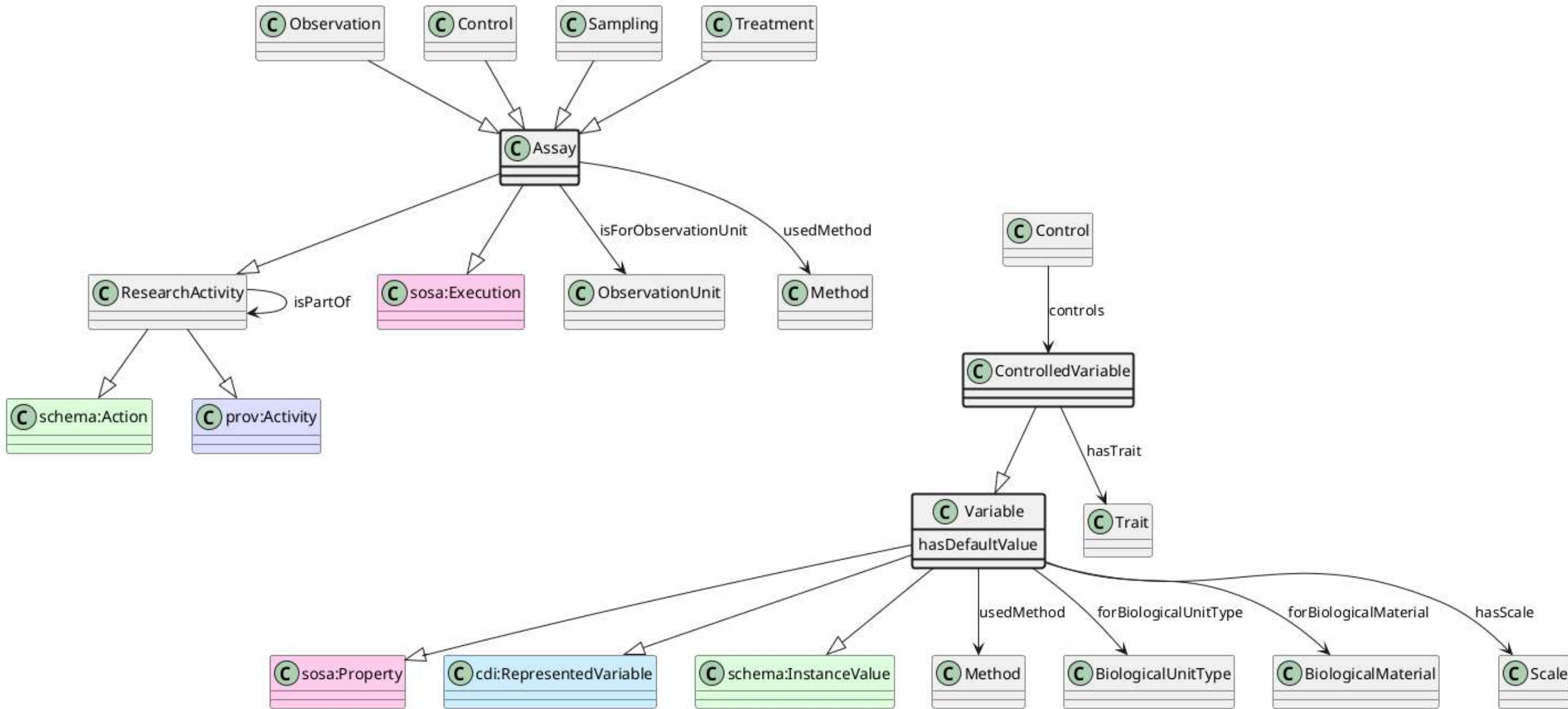
Entity	Time	Property	Value	Method
Cabinet A	t0	Temperature	30C	CabinetSensor
Cabinet A	t0	Humidity	72%	CabinetSensor
Cabinet A	t1	Temperature	31C	CabinetSensor
Cabinet A	t1	Humidity	68%	CabinetSensor
Pot A2	-	Micorrhizae	True	StudyDesign
Pot A2	t0	SoilMoisture	47%	SoilProbe
Pot A2	t1	SoilMoisture	45%	SoilProbe
Plant 2	t0	ImageLateral	100.tif	RGBCamera
Plant 2	t1	ImageLateral	101.tif	RGBCamera
Plant 2	t0	Height	67 mm	CVPipeline
Plant 2	t1	Height	69 mm	CVPipeline
Leaf 2a	t1	NDVI	0.72	HandheldScanner

MIAPPE - Minimum Information About a Plant Phenotyping Experiment



- Minimum information model, MIAPPE:
 - Covers most domain concepts – good starting-point
 - Poor support for machine interoperability
 - Many free-format text elements
 - Missing several essential elements
- APPN supplementing MIAPPE from other models:
 - Provenance → Prov-O
 - Data structures → DCMI
 - Platforms and sensors → SOSA/SSN
 - Software pipelines → Software ontology?
- Adopting CDIF, RO-Crate and JSON-LD

APPN schema – <https://schema.plantphenomics.org.au/>



APPN schema classes

ResearchActivity

Investigation

Study

Assay

Observation

Control

Sampling

Treatment

ObservationUnit

GrowthFacility

Substance

BiologicalUnit

Sample

GrowthFacilityType

BiologicalUnitType

BiologicalMaterial

MaterialSource

Trait

Scale

Method

Variable

ObservedVariable

ControlledVariable

SubstanceQuantity

Observer

Controller

Sampler

Sensor

Actuator

ExternalEvent

Person

SoftwareApplication

Platform

Deployment

Location

SpatialLocation

XYZLocation



Node vocabularies

Institution	Scientist	Entity	Attribute	Upper level terms	Trait name*	Trait description
La Trobe University	Ricarda Jost	plant	growth stages		growth stages	Plant development (doi:10.1111/j.1744-7348.1991.tb04895.x)
La Trobe University	Ricarda Jost	plant growth habit	plant quality trait		overall stature	overall plant phenotype meeting breeding objectives, e.g., compact, enhanced branching, determinate, indeterm
La Trobe University	Ricarda Jost	plant	nutrient supply		nutrient use	Amount of nutrient mix supplied to each plant
La Trobe University	Ricarda Jost	plant	water supply		plant water use	Amount of water supplied to each plant
La Trobe University	Ricarda Jost	leaf	damage		spider mites leaf damage	Spider mites leaf damage scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	damage	insect infestation	thrips leaf damage	Thrips leaf damage scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	damage	insect infestation	whitefly leaf damage	Whitefly leaf damage scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	damage	insect infestation	aphid leaf damage	Aphid leaf damage scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	damage	insect infestation	insect leaf damage	Scale leaf damage scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	infection	fungal infection	Botrytis cinerea infection	Botrytis cinerea infection scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	infection	fungal infection	Powdery mildew infection	Powdery mildew infection scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	infection	fungal infection	leaf rust infection	Leaf rust infection scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	infection	fungal infection	Fusarium infection	Fusarium infection scale as determined by severity scale
La Trobe University	Ricarda Jost	leaf	colour gradient		leaf colour gradient	Leaf colour differences between young mature and old leaves as indicators of leaf senescence
La Trobe University	Ricarda Jost	leaf	nitrogen deficiency		nitrogen deficiency	Plant species specific leaf symptoms that indicate nitrogen deficiency
La Trobe University	Ricarda Jost	leaf	phosphus deficiency		phosphorus deficiency	Plant species specific leaf symptoms that indicate phosphorus deficiency
La Trobe University	Ricarda Jost	leaf	phosphorus toxicity		phosphorus toxicity	Plant species specific leaf symptoms that indicate excess supply of phosphate
La Trobe University	Ricarda Jost	plant	height		plant height	A whole plant morphology trait which is the height of a whole plant
La Trobe University	Ricarda Jost	branch	length		average branch length	Average branch length of all branches of a plant
La Trobe University	Ricarda Jost	plant	width		maximal plant width	Maximal canopy width as extension of longest branches
La Trobe University	Ricarda Jost	stem	width		width of the main stem at base	Width of the main stem measured at its base
La Trobe University	Ricarda Jost	stem	ramification point count		ramification points along stem	A stem morphology trait which is the number of stem nodes. Using cotyledon node as 0, then counting subsequ
La Trobe University	Ricarda Jost	branch	ramification point count		ramification points along branch	Using intersect with main stem as 0, counting subsequent nodes along branch towards its tip
La Trobe University	Ricarda Jost	branch	leaf count		number of leaves	A shoot system morphology trait which is the number of leaves in a shoot system of a plant. Average leaf count
La Trobe University	Ricarda Jost	flower	flower count		number of flowers	An inflorescence morphology trait which is the number of flowers. Physical count of all flowers on a plant
La Trobe University	Ricarda Jost	fruit	ripe fruit count		number of ripe fruit	Physical count of all ripe fruit on a plant
La Trobe University	Ricarda Jost	fruit	unripe fruit count		number of unripe fruit	Physical count of all unripe / green fruit on a plant
La Trobe University	Ricarda Jost	plant	weight		harvest weight	Harvest dry weight of branch, leaf, stem, root, tertiary / fine root, secondary / lateral root, tap root / primary root,
La Trobe University	Ricarda Jost	root	architecture		root architecture	Plant species specific root phenology
La Trobe University	Ricarda Jost	plant	chemical composition		nutrient content results	Laboratory nutrient results from these tissues: branches, leaf, stem, root, tertiary / fine root, secondary / lateral_r
La Trobe University	Ricarda Jost	plant	chemical composition		primary metabolite results	Laboratory metabolite results from these tissues: branches, leaf, stem, root, tertiary / fine root, secondary / later
La Trobe University	Ricarda Jost	plant	chemical composition		elemental composition results	Laboratory elemental composition results from these tissues: branches, leaf, stem, root, tertiary / fine root, seco
La Trobe University	Ricarda Jost	plant	fluorescence trait		leaf fluorescence	Leaf fluorescence data / parameters
La Trobe University	Ricarda Jost	plant	photosynthesis		total amount of carbon fixed by plant/leaf	Leaf carbon assimilation rate

Example node vocabulary

<https://id.plantphenomics.org.au/LTU/>

https://id.plantphenomics.org.au/LTU/ObservedVariable/number_of_leaves

rdfs: label
number of leaves

rdfs: comment
A shoot system morphology trait which is the number of leaves in a shoot system of a plant. Average leaf count on a number of representative branches

skos: altLabel
leaf number

dc: creator
Ricarda Jost

dc: language
English

skos: exactMatch
http://purl.obolibrary.org/obo/TO_0000241

skos: relatedMatch
http://purl.obolibrary.org/obo/TO_0000659

appn: hasTrait
https://id.plantphenomics.org.au/LTU/Trait/leaf_count

appn: hasScale
<https://id.plantphenomics.org.au/LTU/Scale/integer>

appn: usedMethod
https://id.plantphenomics.org.au/LTU/Method/number_of_leaves_method

appn: forBiologicalUnitType
<https://id.plantphenomics.org.au/LTU/BiologicalUnitType/branch>

appn: forBiologicalMaterial
<https://id.plantphenomics.org.au/LTU/BiologicalMaterial/general>

Observed
Variable

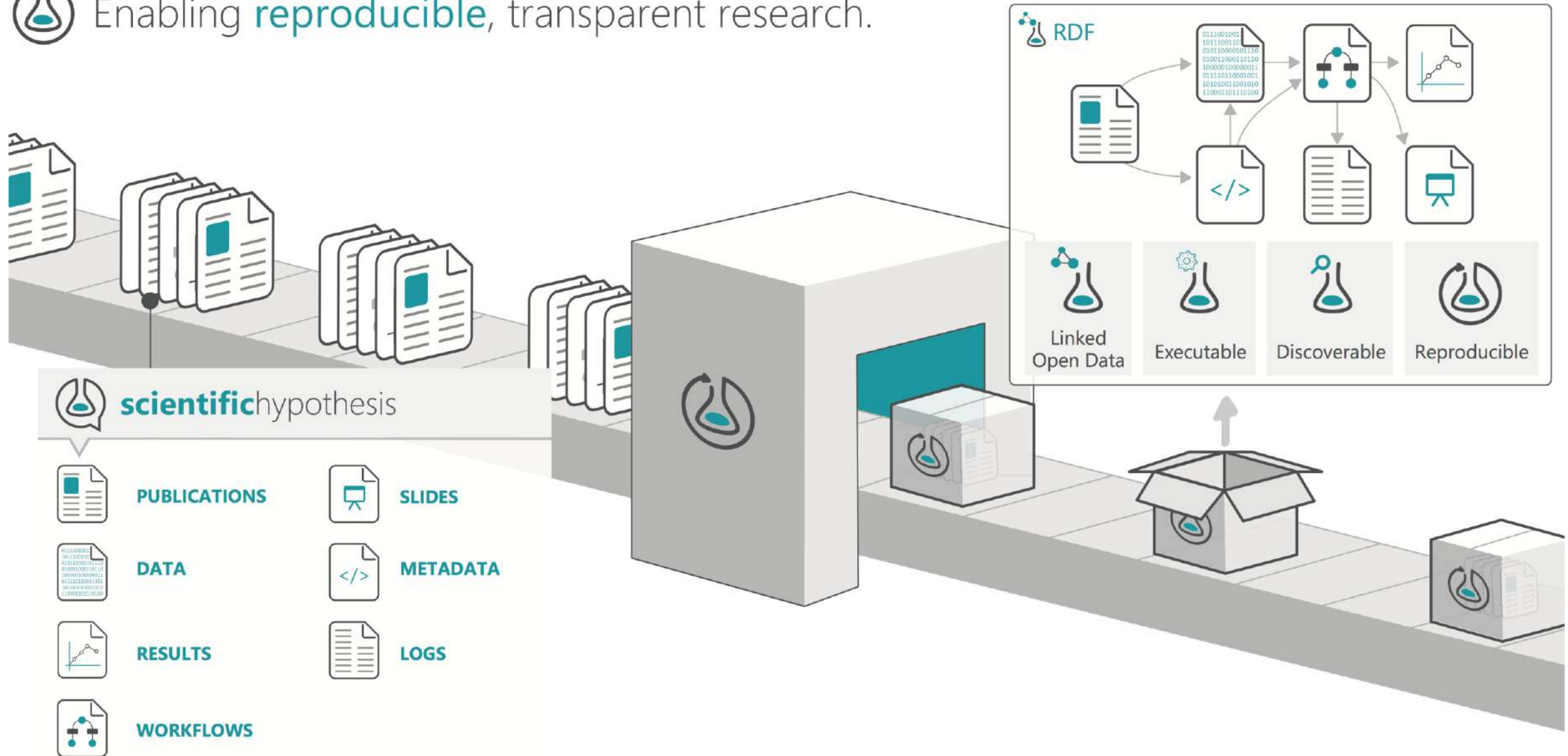
Trait

Scale

Method

RO-Crate

 Enabling **reproducible**, transparent research.



<https://www.researchobject.org/>

RO-Crate from LTU dataset

```
=== this:2024_Exp_3 (Study) ===
description: Optimising N fertilizer application rates for dwarf tomato variety 'Micro Tom' t...
name: Optimising N inputs for dwarf tomato cultivation in protected cropping
  <-- affiliation --> { 2 Organization objects }
  <-- mainEntity --> ./ (Dataset)
  <-- isPartOf --> { 708 Observation objects }
  <-- isPartOf --> { 28 Control objects }
  <-- isPartOf --> { 8538 Treatment objects }

=== this:2024_Exp_3_2_78_pot (GrowthFacility) ===
name: 2024_Exp_3_2_78_pot

>-- hasGrowthFacilityType -->
  === https://id.plantphenomics.org.au/appn/GrowthFacilityType/Pot (GrowthFacilityType) ===
  name: Pot
  <-- hasGrowthFacilityType --> { 156 GrowthFacility objects }

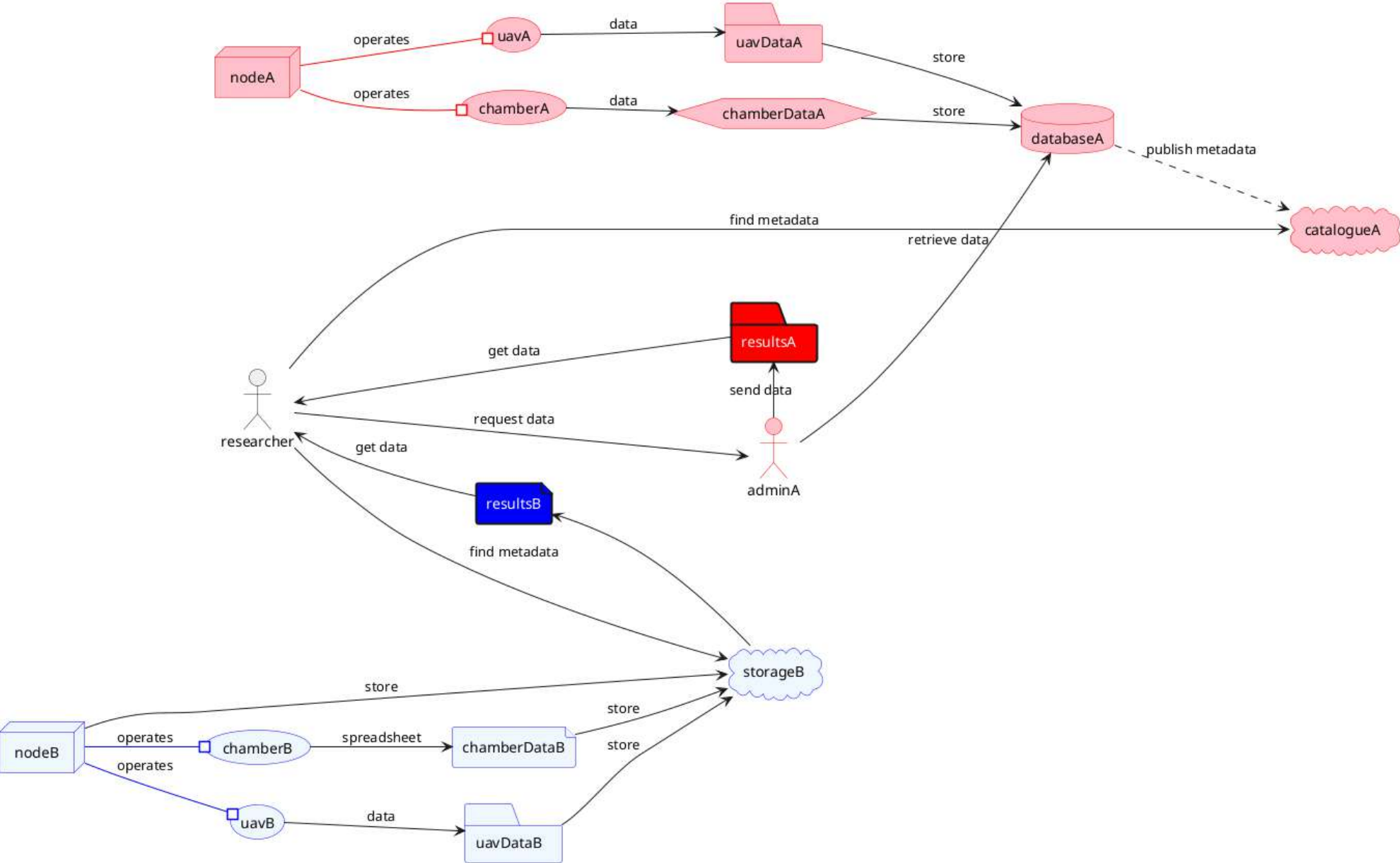
>-- hasLocation -->
  === this:c103_F13 (XYZLocation) ===
  column: 13
  endTime: 2024-11-01T00:00:00
  name: c103_F13
  row: F
  startTime: 2024-10-17T00:00:00
  >-- isLocationWithin --> this:c103 (GrowthFacility)
  <-- hasLocation --> { 2 GrowthFacility objects }

>-- hasLocation -->
  === this:c105_F13 (XYZLocation) ===
  column: 13
  name: c105_F13
  row: F
  startTime: 2024-11-01T00:00:00
  >-- isLocationWithin --> this:c105 (GrowthFacility)
  <-- hasLocation --> this:2024_Exp_3_2_78_pot (GrowthFacility)

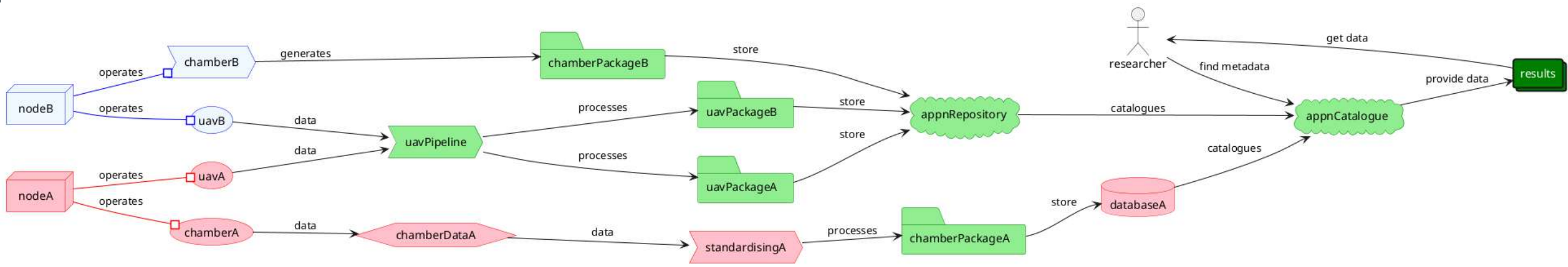
<-- isForObservationUnit -->
  === this:2024_Exp_3_2_78_pot_potting (Treatment) ===
  name: 2024_Exp_3_2_78_pot_potting
  startTime: 2024-10-17T00:00:00
  >-- treatsWith --> this:cocoperlite_35_65_4.5L (SubstanceQuantity)
  >-- isForObservationUnit --> this:2024_Exp_3_2_78_pot (GrowthFacility)
  >-- isPartOf --> this:2024_Exp_3 (Study)
```

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    "jobTitle": "Senior Research Fellow",
    "name": "Ricarda Jost"
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    "name": "Optimising N inputs for dwarf tomato cultivation in protected cropping"
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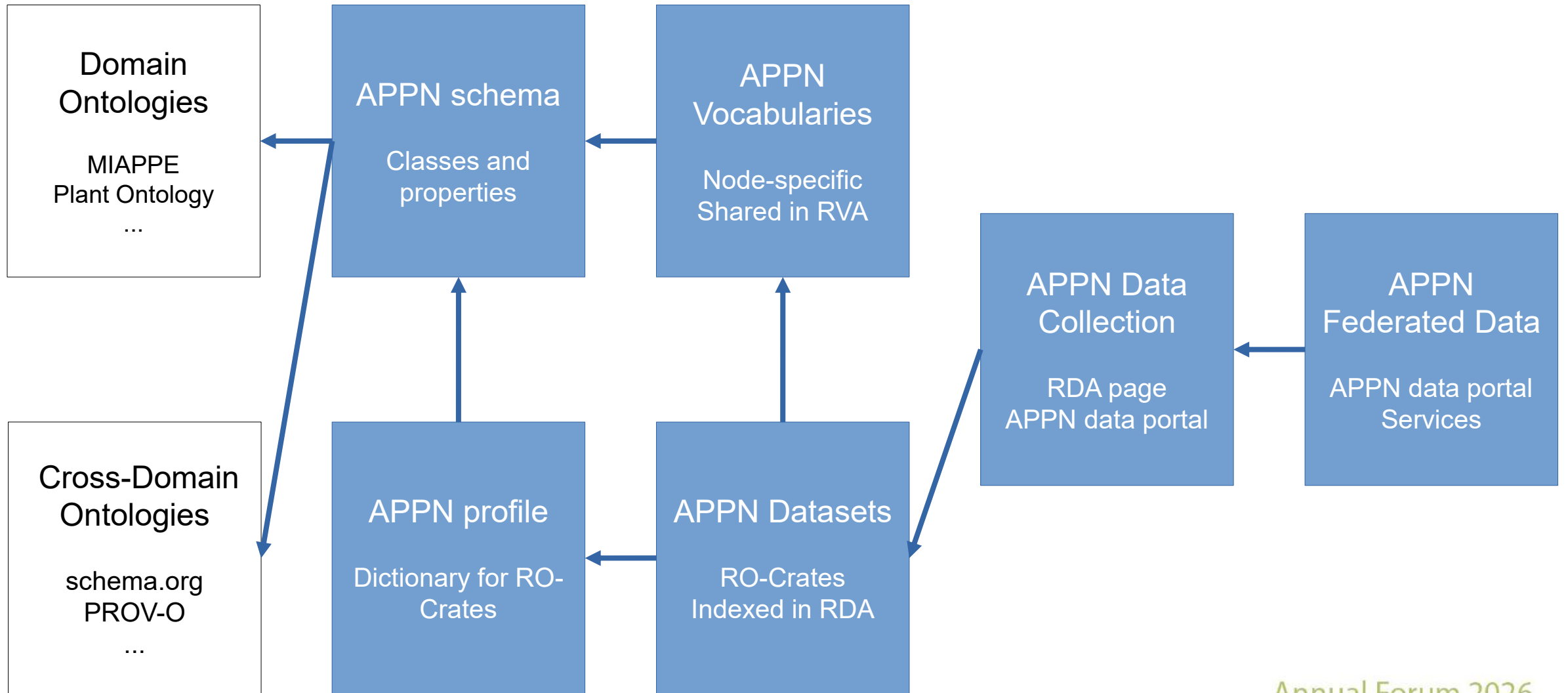
Decentralised data publishing



Federated data publishing



FAIRifying APPN data





APPN

Australian Plant Phenomics Network

plantphenomics.org.au

We are proudly supported by

NCRIS

National Research
Infrastructure for Australia
An Australian Government Initiative

APPN plant phenotyping infrastructure and expertise is strategically located at nine locations across Australia:



Australian
National
University



Charles Sturt
University



Department of
Primary Industries and
Regional Development



LA TROBE
UNIVERSITY



**THE UNIVERSITY
OF QUEENSLAND**
AUSTRALIA



THE UNIVERSITY OF
SYDNEY



THE UNIVERSITY OF
**WESTERN
AUSTRALIA**

WESTERN SYDNEY
UNIVERSITY



Image-Based Phenotyping of Fusarium Head Blight of Wheat and Barley in the Field

Brian Steffenson, Julian Cooper, Ce Yang & Cory Hirsch

**University of Minnesota
Saint Paul**

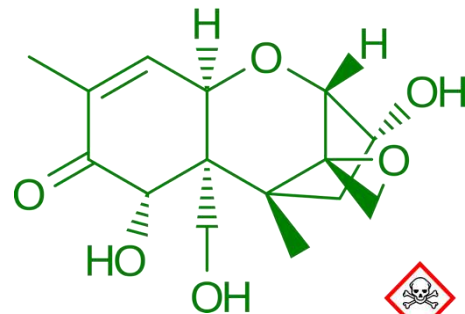


Fusarium Head Blight

- Devastating disease of wheat and barley
- Severe epidemics started in 1993
- Disease is now important worldwide
- Mycotoxin contamination of grain
- Beer gushing & other end-use problems



Beer gushing



Deoxynivalenol or DON



On wheat



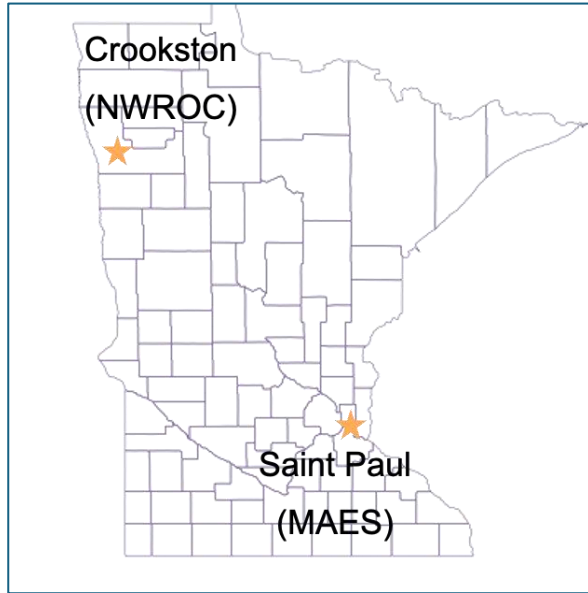
On barley

FHB Epidemics

A Catastrophic Calamity for Small Grains

- ❖ Since 1993, losses approaching \$4 billion were incurred by producers & end-users alike in the supply chain in North America
- ❖ Health risks to humans & animals due to mycotoxins in infected grain
- ❖ Human hardship & stress due to loss of farms & markets caused by the disease
- ❖ Cumulative FHB epidemics on wheat & barley since 1993 rank among worst disease-mediated agricultural disasters in U.S. history

Resistance Screening Nurseries: USA



Disease scoring



Crookston FHB nursery



St. Paul FHB nursery

Extensive Search for Resistance



20 years of screening on
>25,000 *Hordeum* accessions in the USA and China

- 247 accessions identified with moderate resistance
- 11 selected accessions were used as parents in mapping populations
- Recently, 8 other accessions with different haplotypes at FHB resistance loci were used for the development of a MAGIC population

Challenges in Screening Barley for FHB Resistance

Labor, time and cost for phenotyping



Phenotyping fun!

Associations with agro-morphological traits

June 26
June 28
July 1



Heading Date



2/6 row



Lax/dense



Grinding samples



Assaying mycotoxins with GC-MS



Height



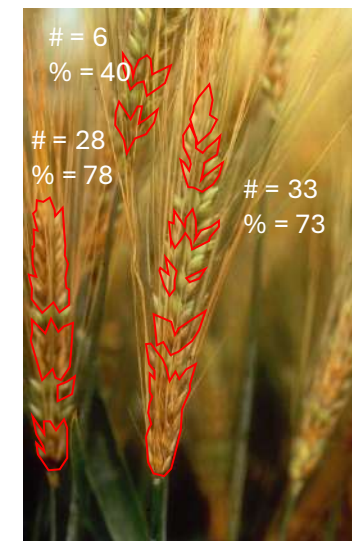
Hulled



Hulless

Fusarium Head Blight

- High level of variation for FHB infection occurs on individual spikes within a row of a single genotype



- Need to sample as many spikes as possible from plots for best resolution of performance

Individual spikes are rated for infected to derive plot level severities



Scoring yield plots for FHB severity



Disease Assessment

Infected Kernel Counts

- Disease assessment can be a laborious task
- When evaluating mapping populations, we aimed for the highest resolution
- Thus, we arbitrarily selected 10-20 spikes from a row and counted the number of infected and total number of kernels on each spike to derive a severity

Scoring FHB in the field: the most *hated* task during the summer field season



= total number of visible infected kernels

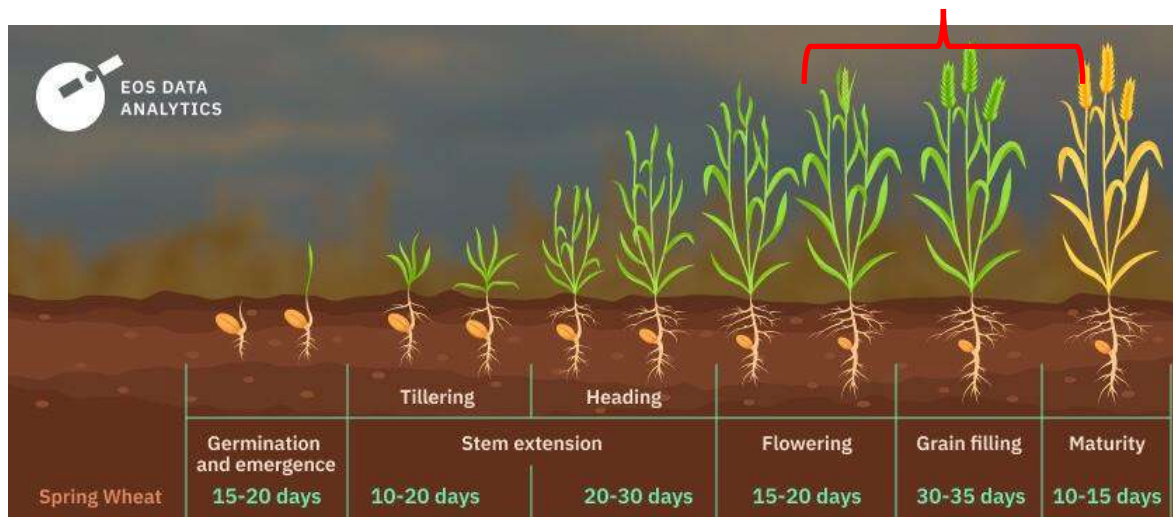
% = percent of kernels infected per spike

Manual FHB Ratings

- The small subsample of spikes scored may not be representative of plot-level severity
- Manual assessment methods: slow, expensive & variable (e.g. rater fatigue, inter-rater variation)
- Ratings taken at one time point only
- Optimal window for scoring is brief



Manual scoring in the field



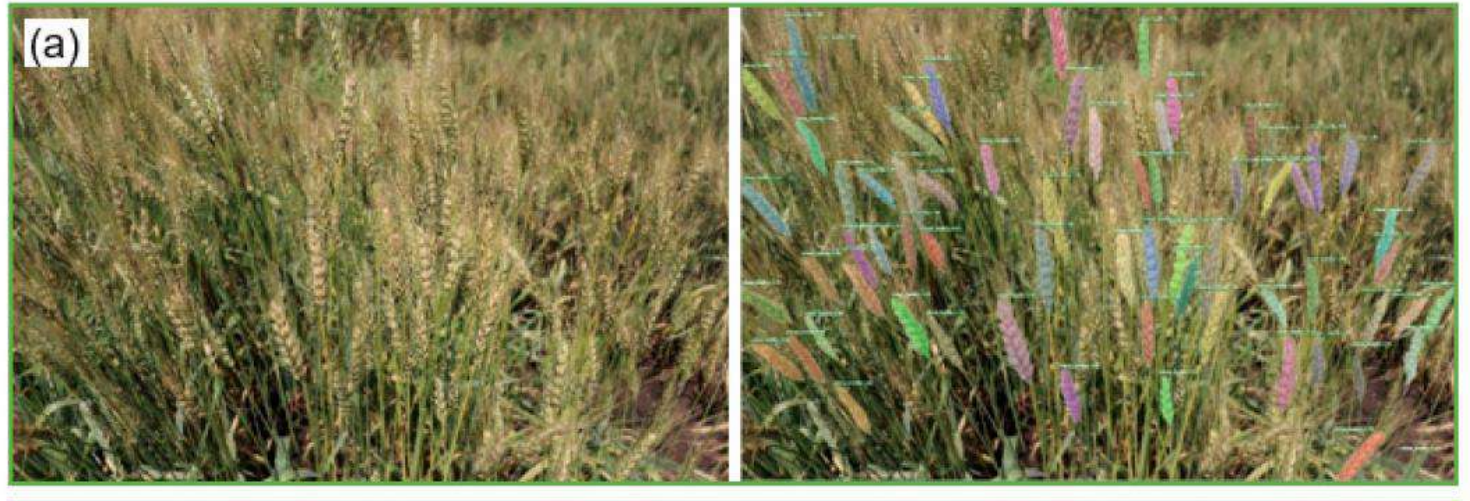
About a 2-3 week window for optimal scoring

Disease Assessment

Early Image Analysis Research



Early image analysis protocol

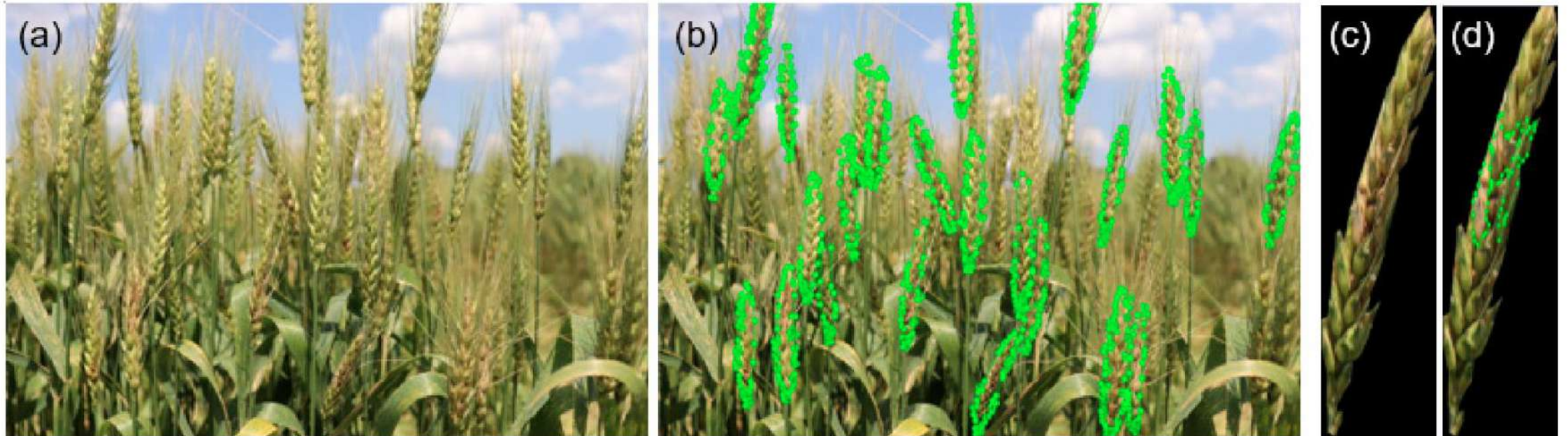


Detection of spikes by image analysis under a complex scenario

A cart mounted with two digital cameras was moved through the field to record images of each barley line

Initial Study from Manually Collected Digital Images

Spike and Infected Floret Annotation



a) Full-size spikes in a row

b) Same image but with annotated spikes

c) Segmented sub-image of single spike; and **d)** Image from 'c' but annotated with infected kernels

This Method is Not High Throughput!



Mineral X Company

Robot for Crop Phenotyping

BBC

Google reveals Mineral crop-inspecting robots

14 October 2020

Share Save



Mineral X robots capturing images in field



Imaging pod number & seeds in soybean



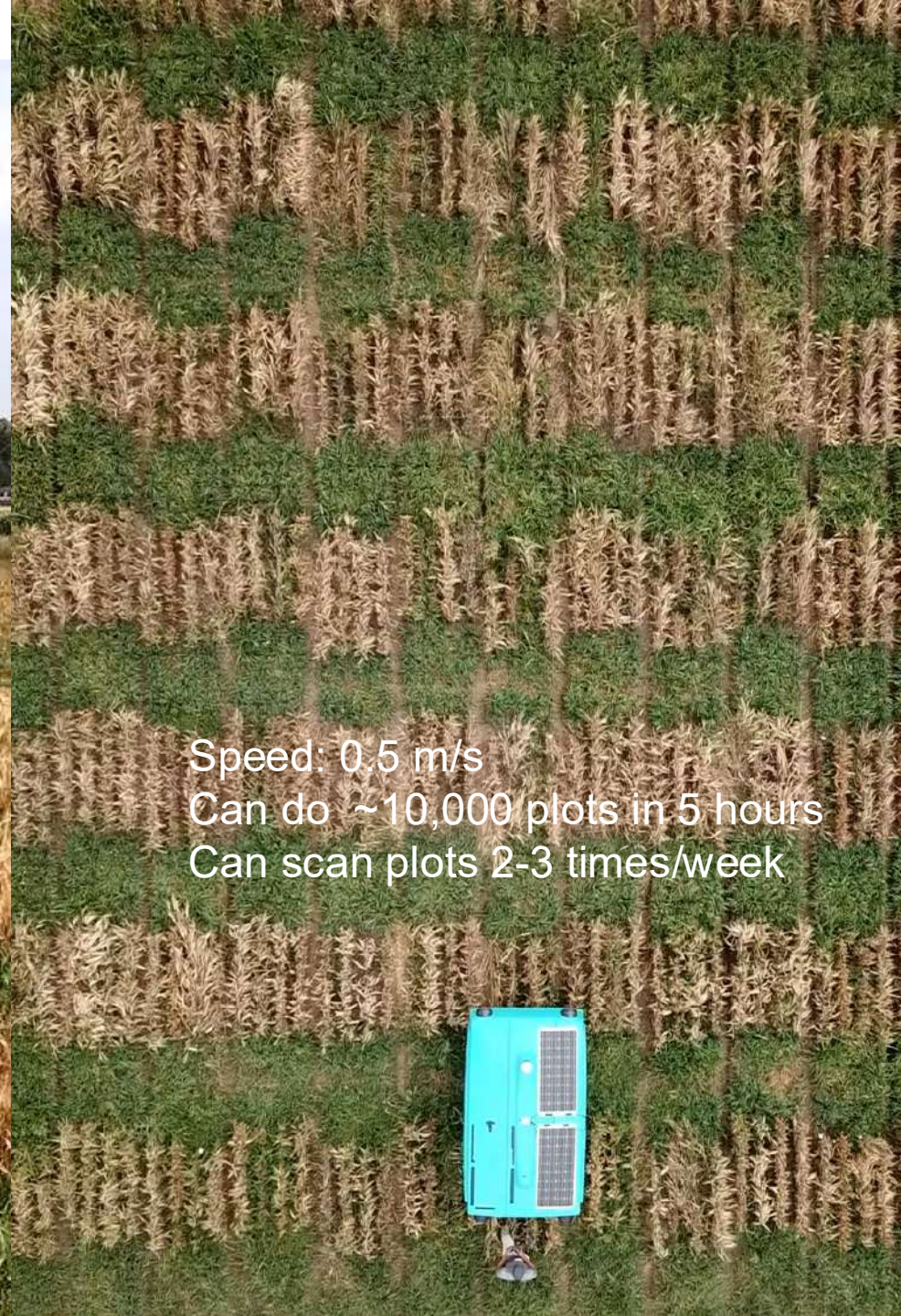
Funding obtained through the U.S. Wheat and Barley Scab Initiative

News article forwarded to me by Ce Yang on October 16, 2020

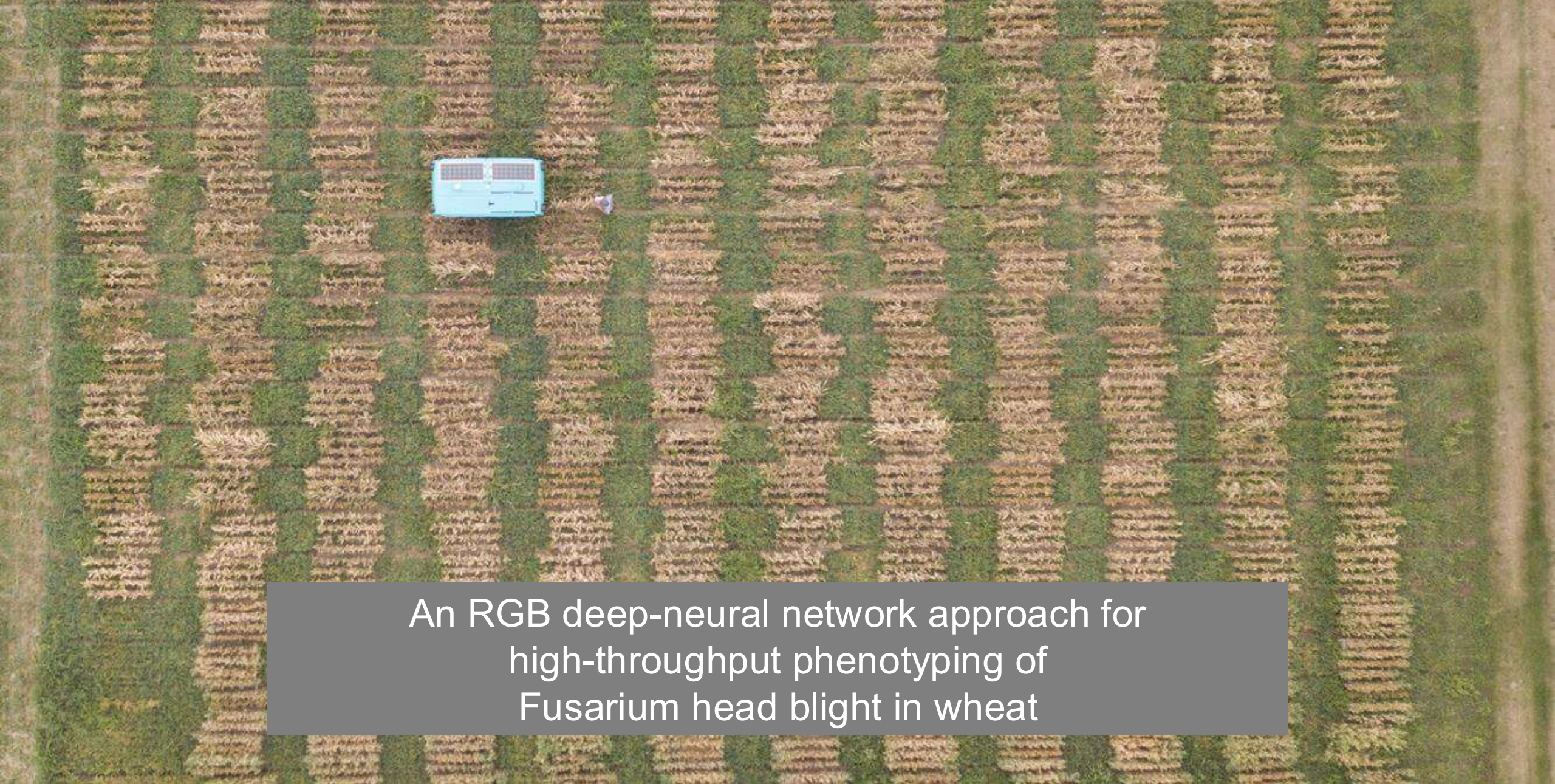
mineral Phenotyping Rover



Speed: 0.5 m/s
Can do ~10,000 plots in 5 hours
Can scan plots 2-3 times/week



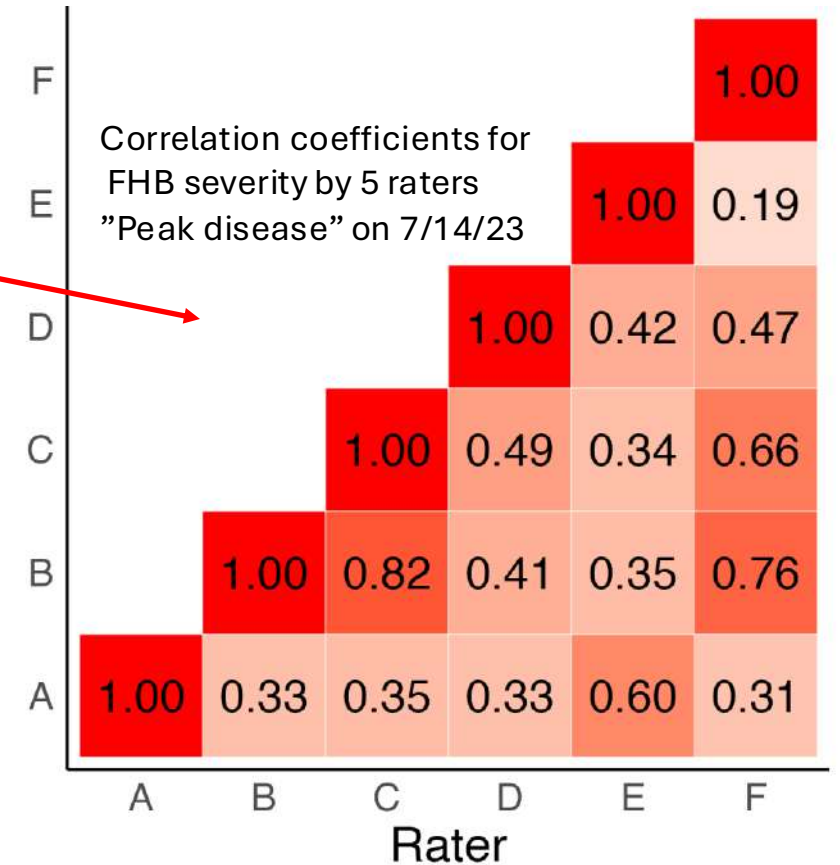
Collecting Additional & More Reliable Data



An RGB deep-neural network approach for high-throughput phenotyping of Fusarium head blight in wheat

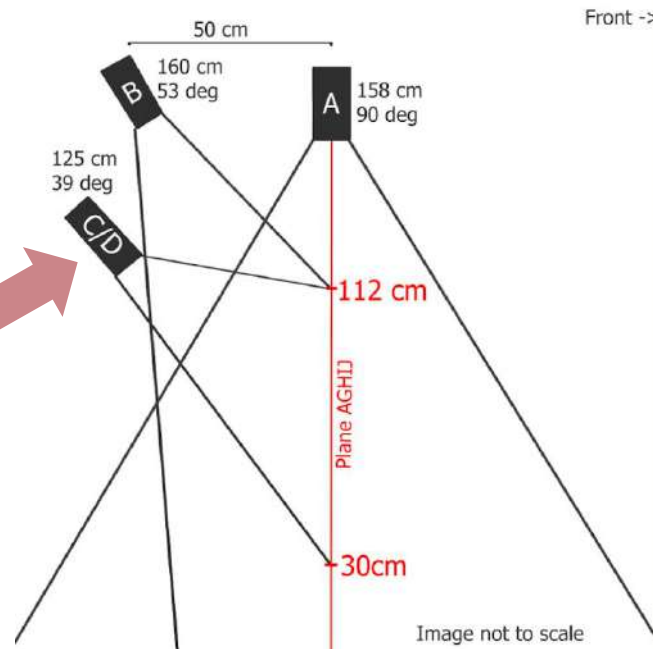
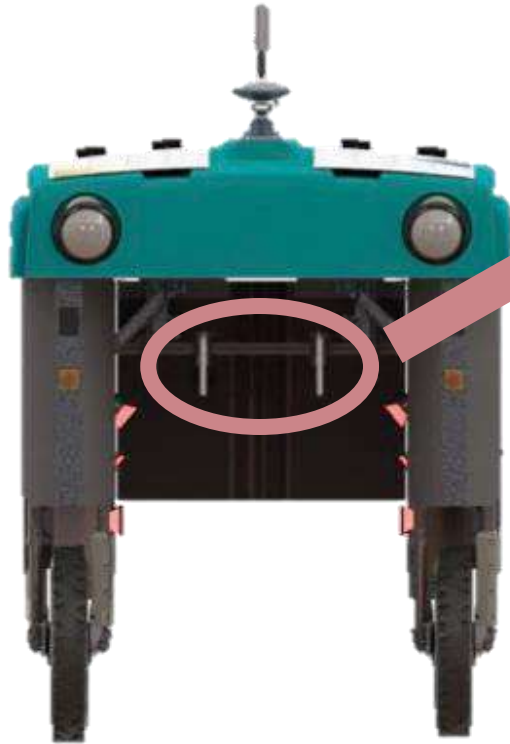
Benefits of Phenotyping with the Rover

- Can score many spikes per plot
- Can score plots multiple times during the season
- Can greatly reduce the time & cost of phenotyping
- Eliminates subjective ratings



r range of 0.19 to 0.82

Images from 2022 were Used to Assess the Pipeline



Down sampled to 8 total images, 4 from each camera





Image Analysis Pipeline



Chuan
Du



Zachary
Beaver

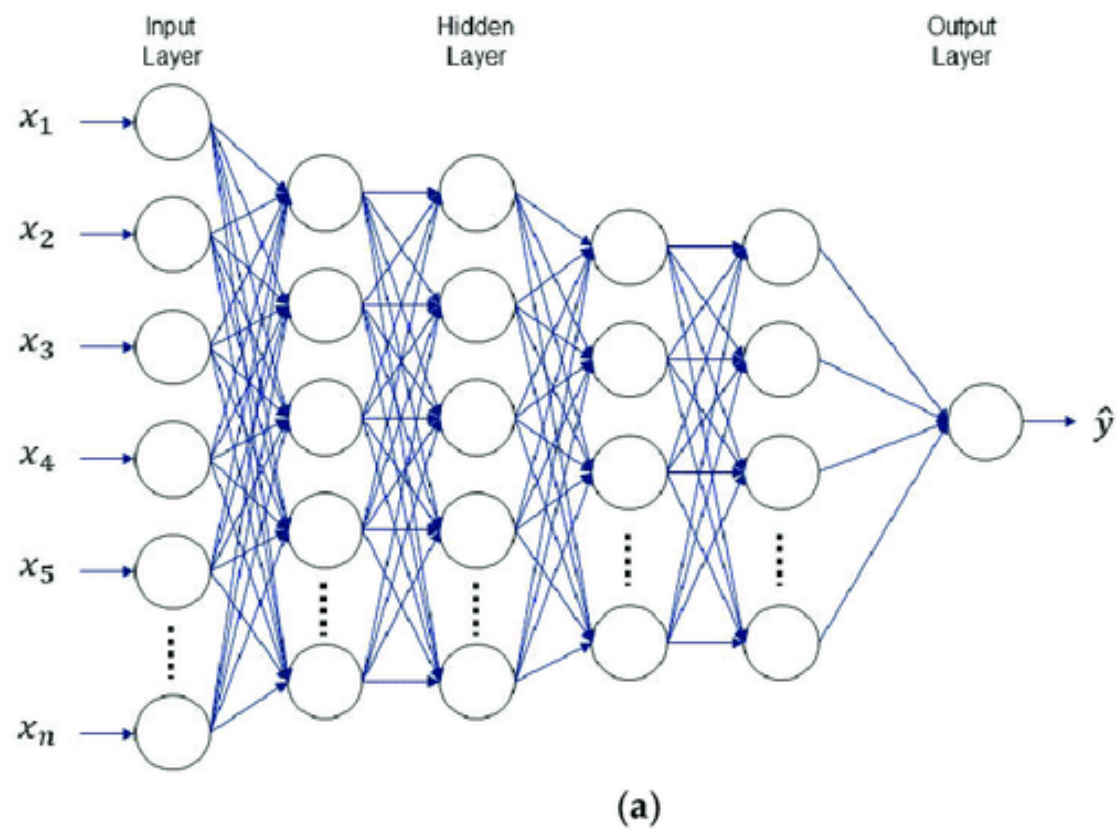




Image Analysis Pipeline



Raw Images



:



Chuan
Du



Zachary
Beaver



Image Analysis Pipeline



Raw Images



:



1

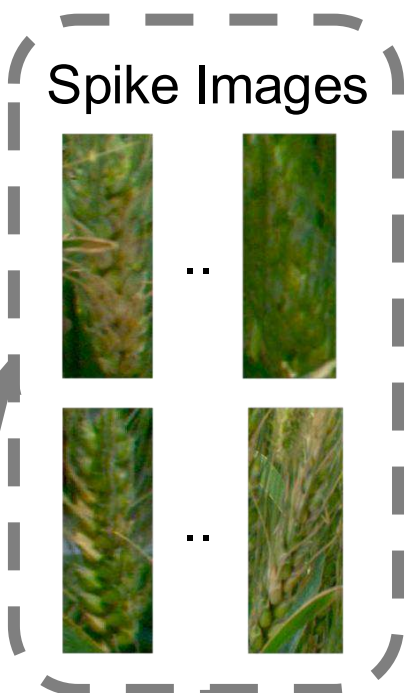


Spike
Detection

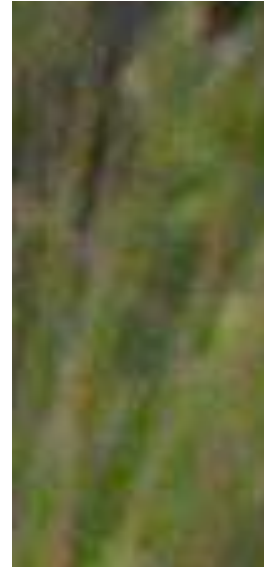




Image Analysis Pipeline



Quality



Overexposed



Incomplete



Occluded

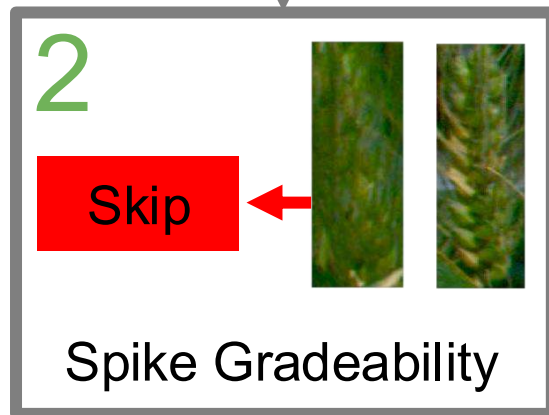




Image Analysis Pipeline

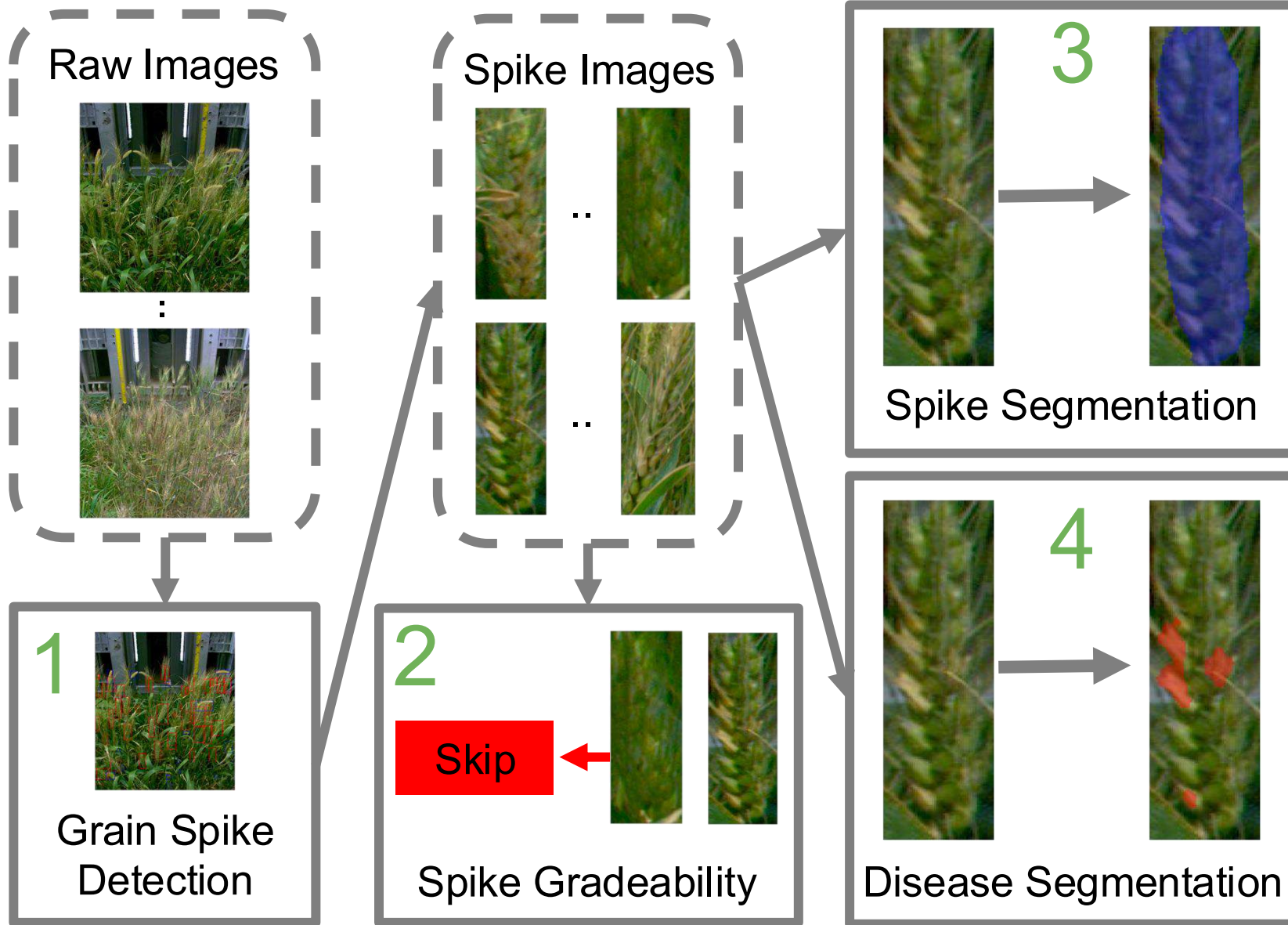
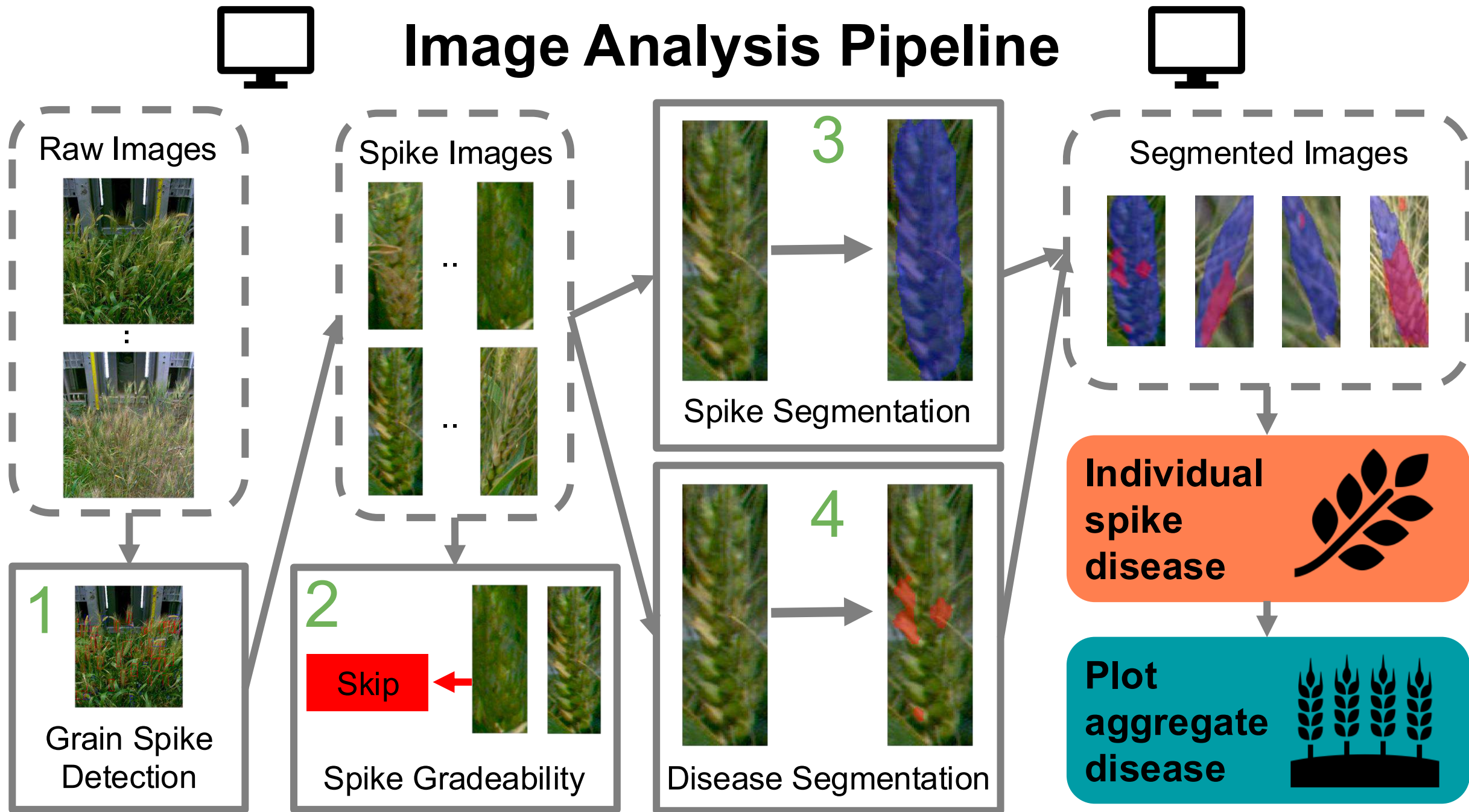
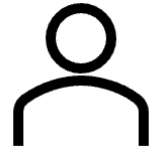
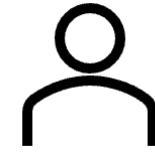


Image Analysis Pipeline





Disease Validation Datasets



×3

Validation datasets

2022

Field disease ratings and manual image annotations



Single **SPIKE** disease scoring



PLOT average



Dr. Rae Page



Dr. Oadi Matny



Tamas Szinyei



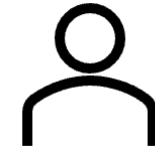
Alejandra Quiñones



Kevin Propst



Disease Validation Datasets



×3

Validation datasets

2022

Field disease ratings and manual image annotations



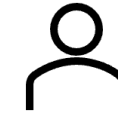
Single **SPIKE** disease scoring



PLOT average



Pipeline



Human



Field



Image



Spike

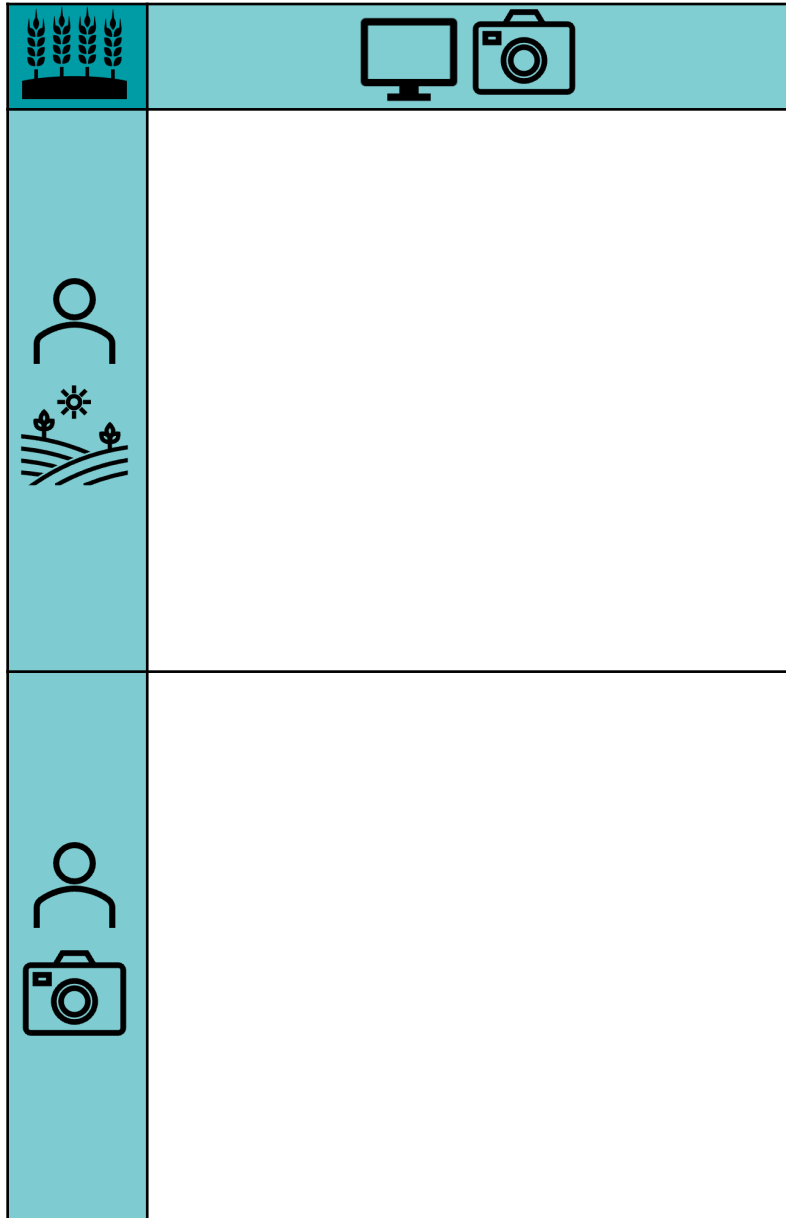


Plot

Pipeline Can Accurately Quantify FHB at Plot Level

 5 raters

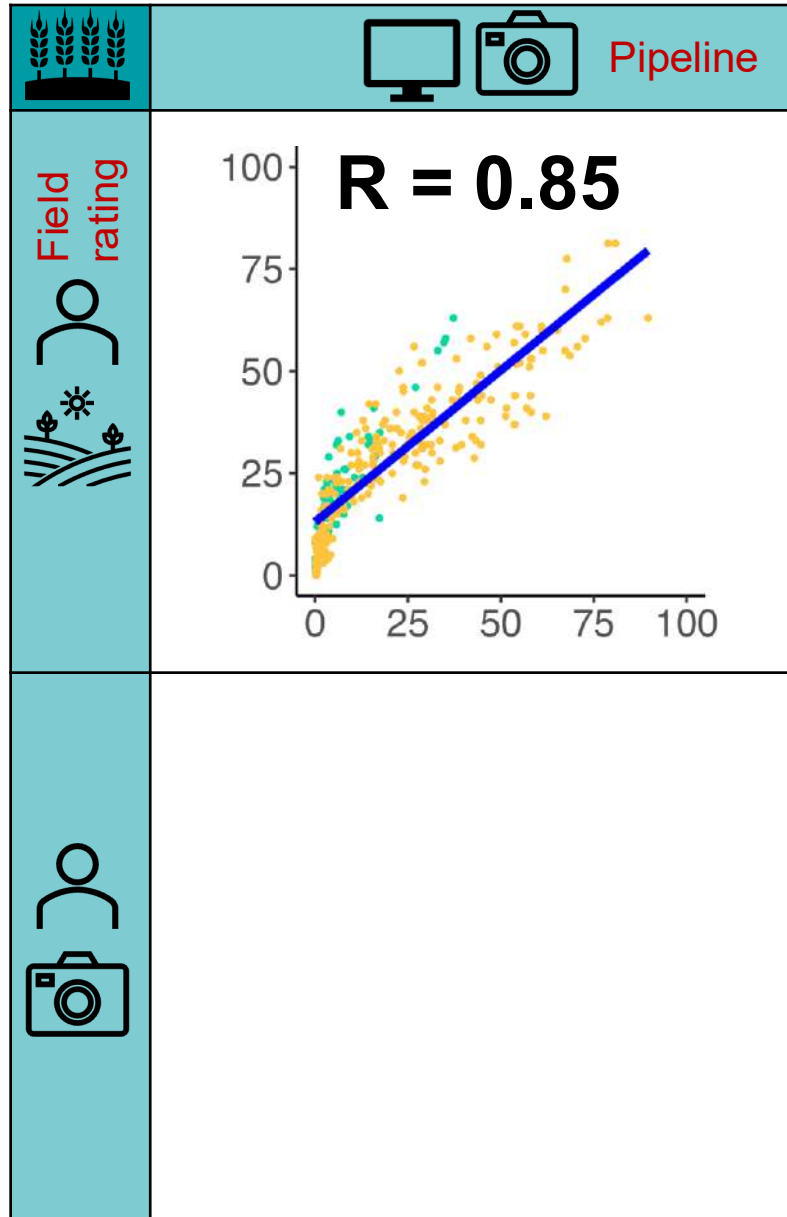
 Field



Pipeline Can Accurately Quantify FHB at Plot Level

 5 raters

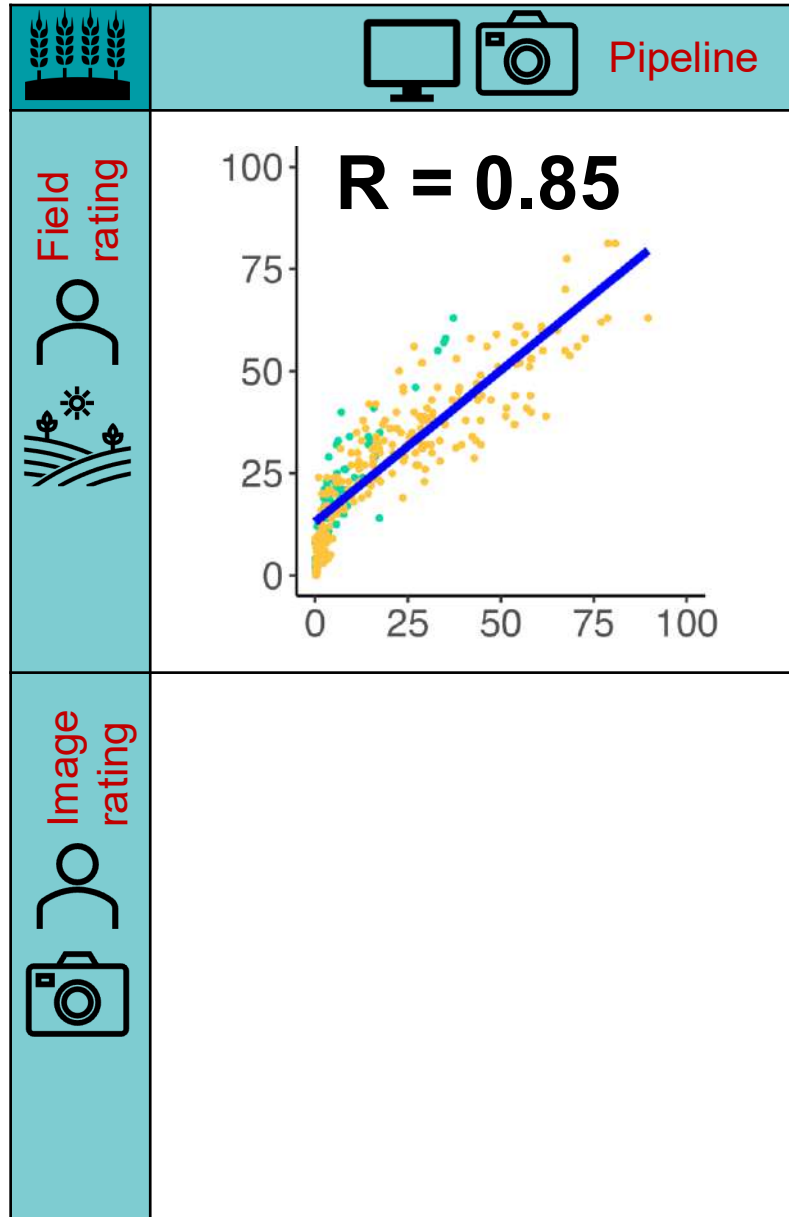
 Field



Pipeline Can Accurately Quantify FHB at Plot Level

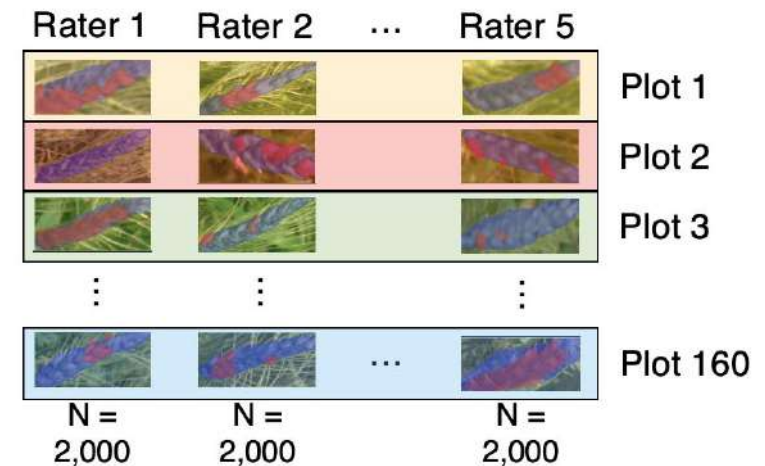
 5 raters

 Field



 5 raters

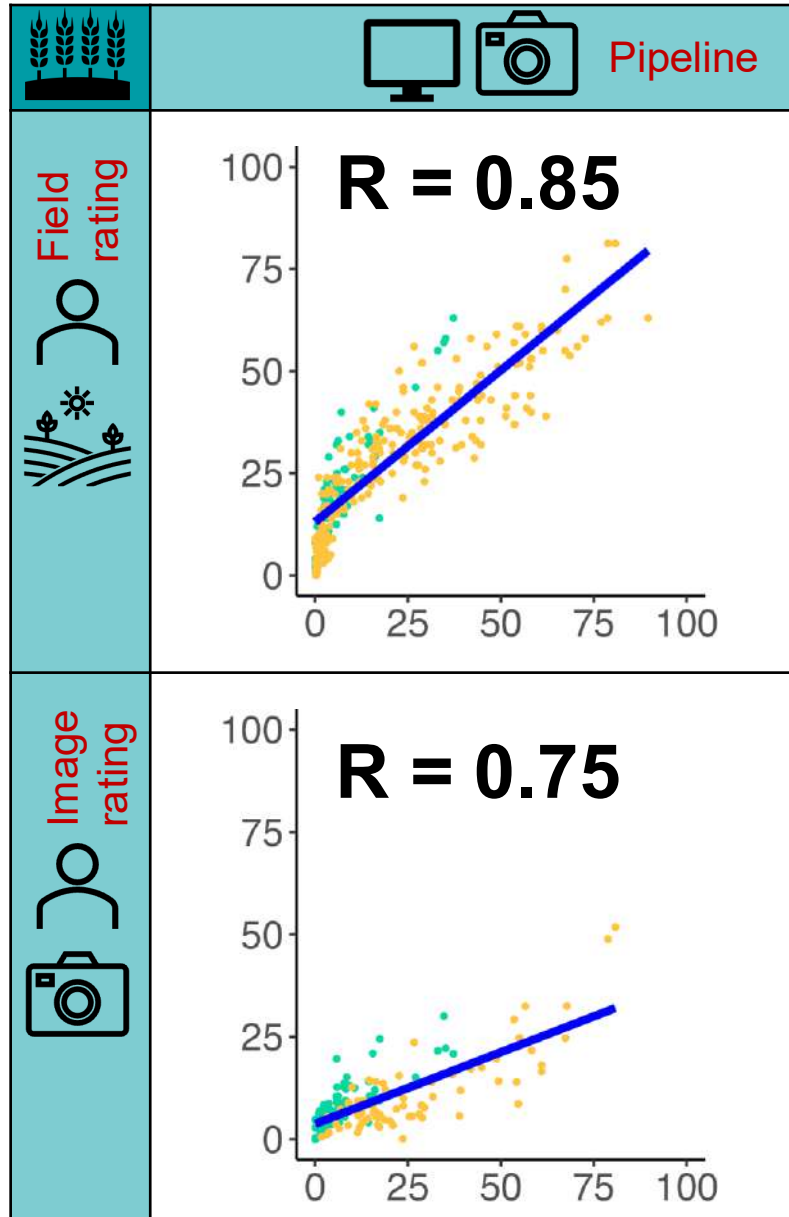
 Image




Pipeline Can Accurately Quantify FHB at Plot Level

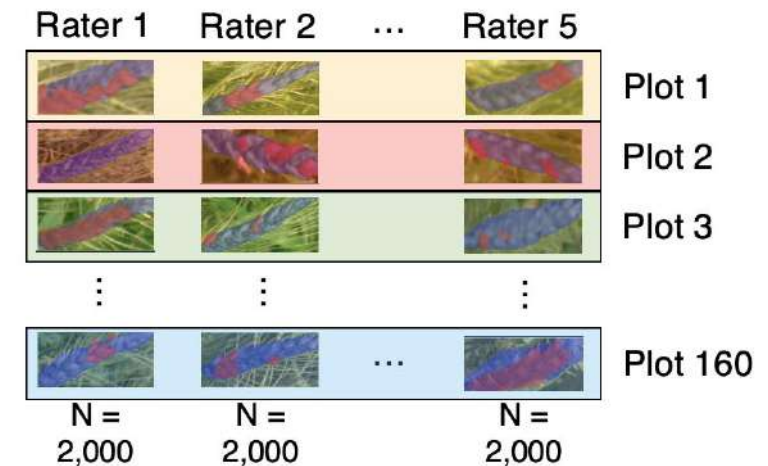
 5 raters

 Field



 5 raters

 Image



Summary



- A robust model was developed for the identification of wheat spikes and diseased florets from images taken in the field

New Results

[Follow this preprint](#)

An RGB based deep neural network for high fidelity Fusarium head blight phenotyping in wheat

Julian Cooper, Chuan Du, Zach Beaver, Ming Zheng, Rae Page, Joseph R. Wodarek, Oadi Matny, Tamas Szinyei, Alejandra Quiñones, James A. Anderson, Kevin P. Smith, Ce Yang, Brian J. Steffenson, Cory D. Hirsch

doi: <https://doi.org/10.1101/2023.09.20.558703>

This article is a preprint and has not been certified by peer review [what does this mean?].



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Summary



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Summary



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- This will increase the sample size & accuracy of FHB assessments, while reducing the time and eventually the cost
- There are high upfront costs for this technology
- The rover is also over-engineered and heavy
- NMBU's rover offers several advantages and images taken from it work with the model we developed

Mobile Phones: An Accessible & High-throughput Phenotyping Solution



Adapting Pipeline to Single Row Plots

Raw Image

Plot Grouping

AB

CD



Region of Interest

Plot Grouping

AB

CD



Plot Division

A

B

C

D

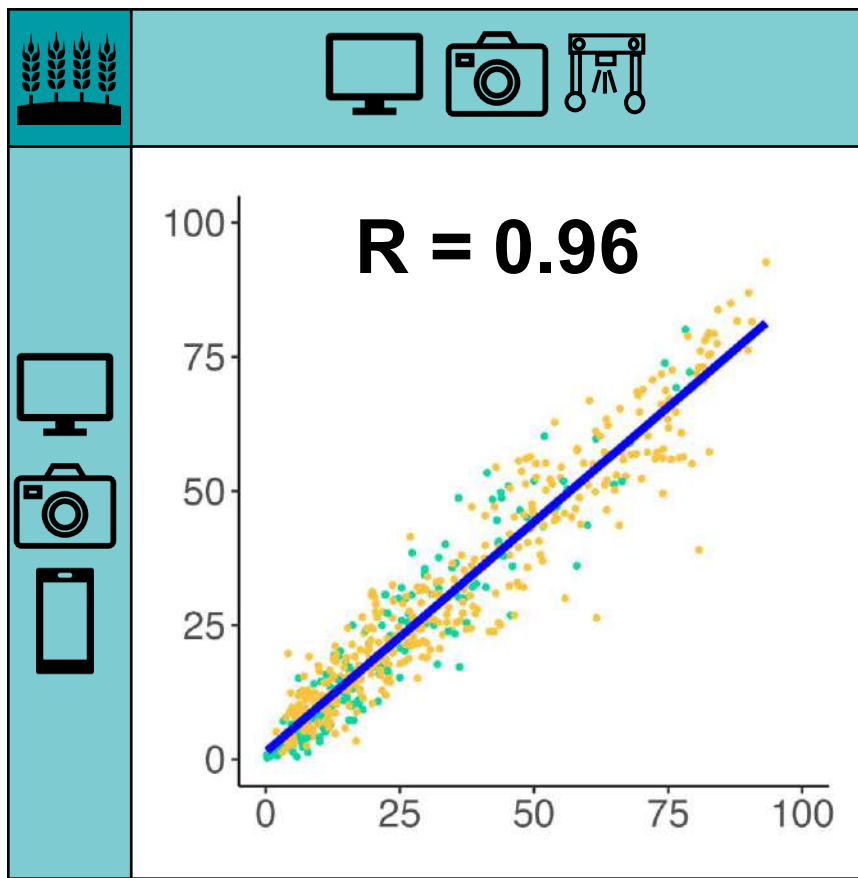


Pipeline Disease Inferences Translate Across Rover 🚗 and Mobile 📱 Images

2023 Mobile



2023 Rover



Saint Paul, MN

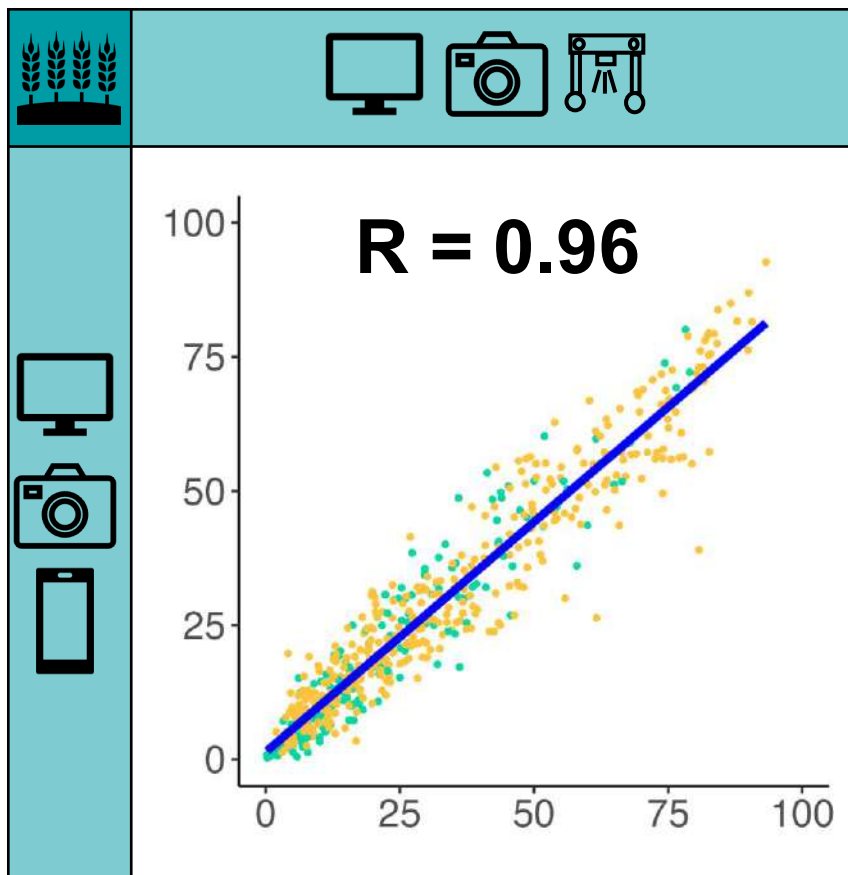
Crookston, MN

Pipeline Disease Inferences Translate Across Rover 🚗 and Mobile 📱 Images

2023 Mobile



2023 Rover



Saint Paul, MN

Crookston, MN



Mobile – Field Correlation

2023: 0.82

2024: 0.82



U.S. Wheat & Barley
Scab Initiative



mineral

Steffenson Lab



Brian
Steffenson



Rae
Page



Oadi
Matny



Tamas
Szinyei



Chuan
Du



Zachary
Beaver

Hirsch Lab



Cory
Hirsch



Alejandra
Quiñones



Kevin
Propst

Co-Investigators



Joseph
Wodarek



Ce Yang



Kevin Smith

Questions?





LITHUANIAN
RESEARCH CENTRE
FOR AGRICULTURE
AND FORESTRY

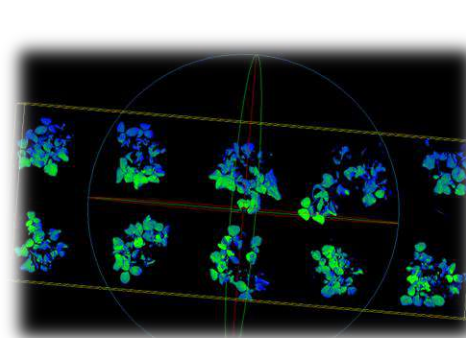
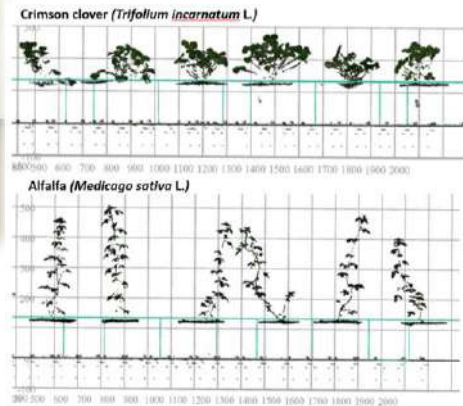


PHENOSPEx
Smart Plant Analysis

TraitFinder: 3D Multispectral phenotyping for plant research

Dr. Rita Armonienė
rita.armoniene@lammc.lt

Data management workshop – From Phenotyping Experiment to FAIR Data, 12th March, 2026



Content



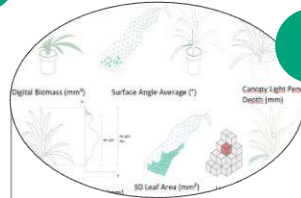
Introduction

- TraitFinder
- PlanEye



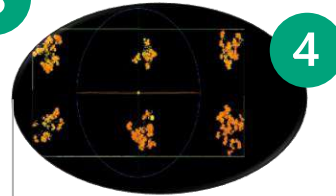
Workflow

- Hortcontrol
- DATA files



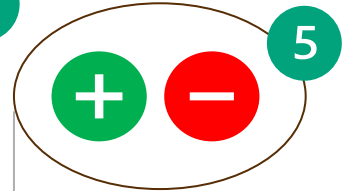
Parameters

- Morphological
- Spectral
- Vegetation indices



Experience

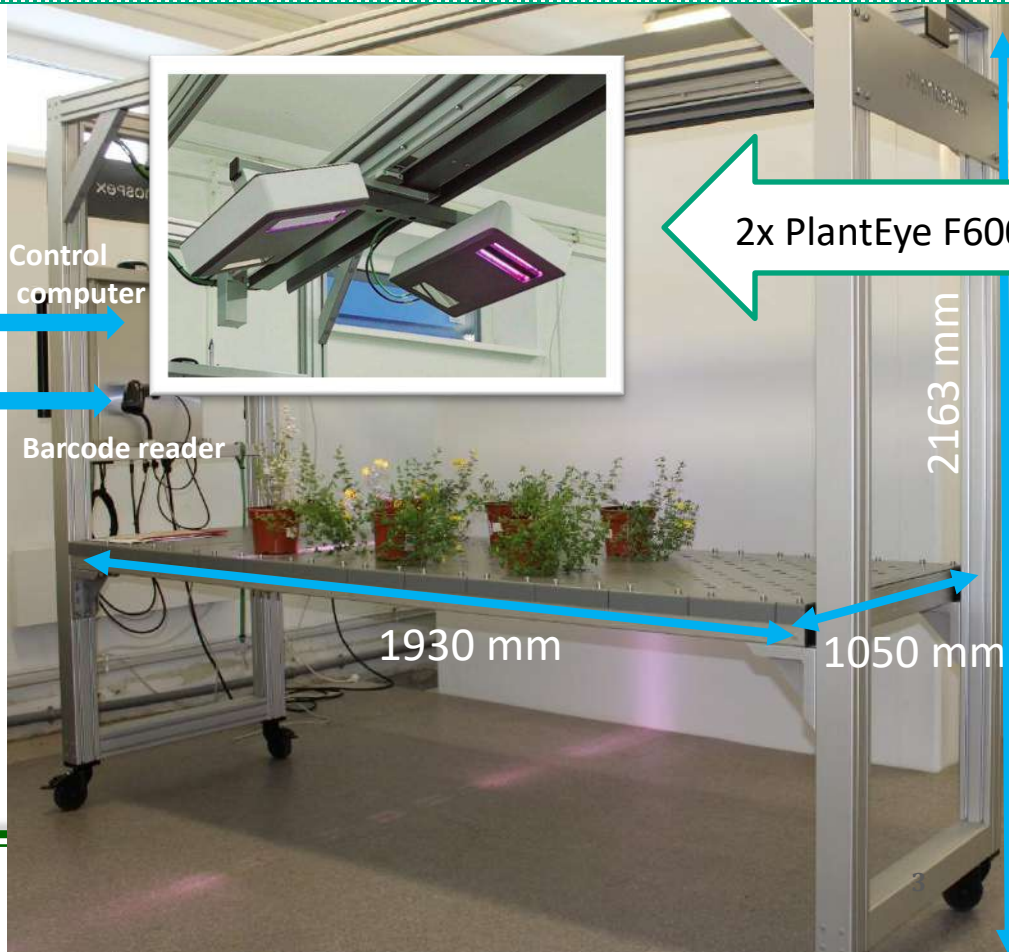
- Mistakes & Lessons
- Our examples



Pros @ Cons

TraitFinder - high-throughput plant phenotyping system

PHENOSPEx
Smart Plant Analysis



Control
computer

Barcode reader

2x PlantEye F600 Multispectral 3D scanner

1930 mm

1050 mm

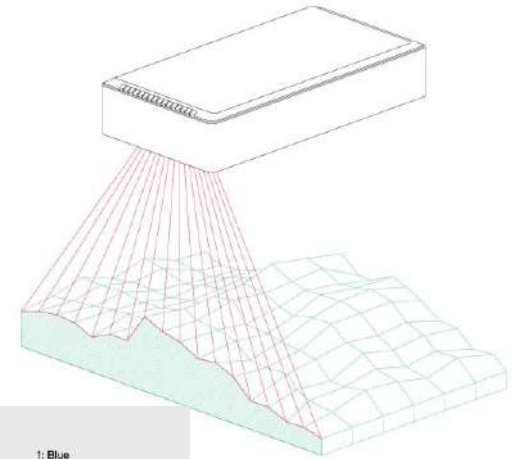
2163 mm

- 3D scanning
- Multi-spectral color recording
- Independent from light conditions
- High resolution (< 1 mm)
- Repeatable
- Open data formats
- Heavy-duty design - IP67

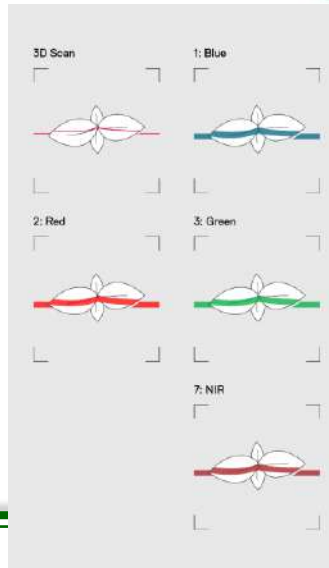
LAMMC

PlantEye F600 Multispectral 3D scanner

- A laser line is used to collect 3D coordinate data
- The 3D coordinate data is used to calculate morphological parameters
- Multi-spectral color recording for spectral parameters.



Color	Peak Wavelength	Spectral half-width
Red (R)	624-634 nm	20 nm
Lime Green (G)	530-540 nm	80 nm
Blue (B)	465-485 nm	20 nm
Near Infrared (NIR)	720-750 nm	20 nm
Laser	935-945 nm	1.5 nm

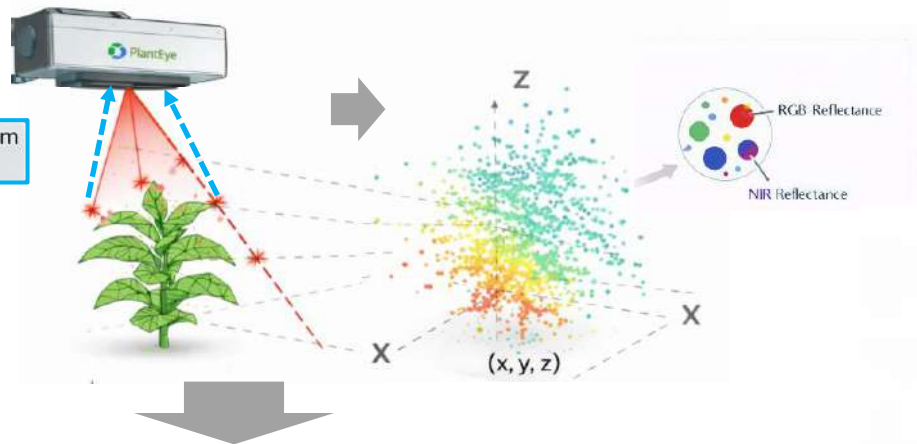


3D Plant Phenotyping pipeline

Capture Reflectance

Generate 3D Point Cloud

Distance: 45.3 cm
Angle $\theta = 57^\circ$



Transform

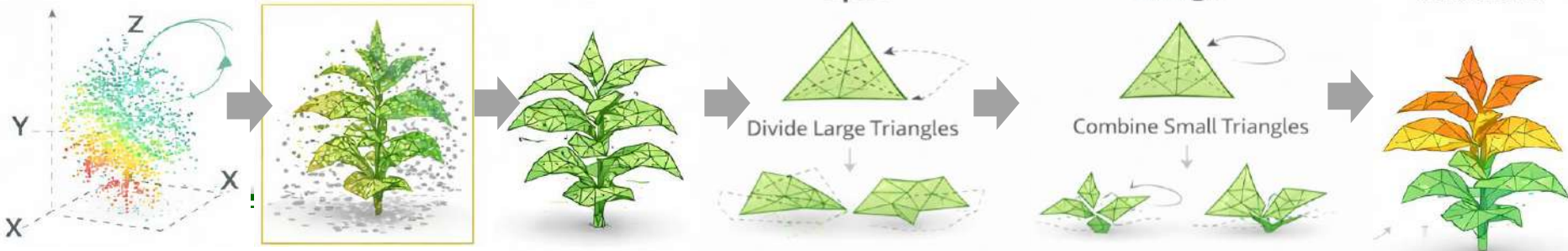
Segment

Triangulate

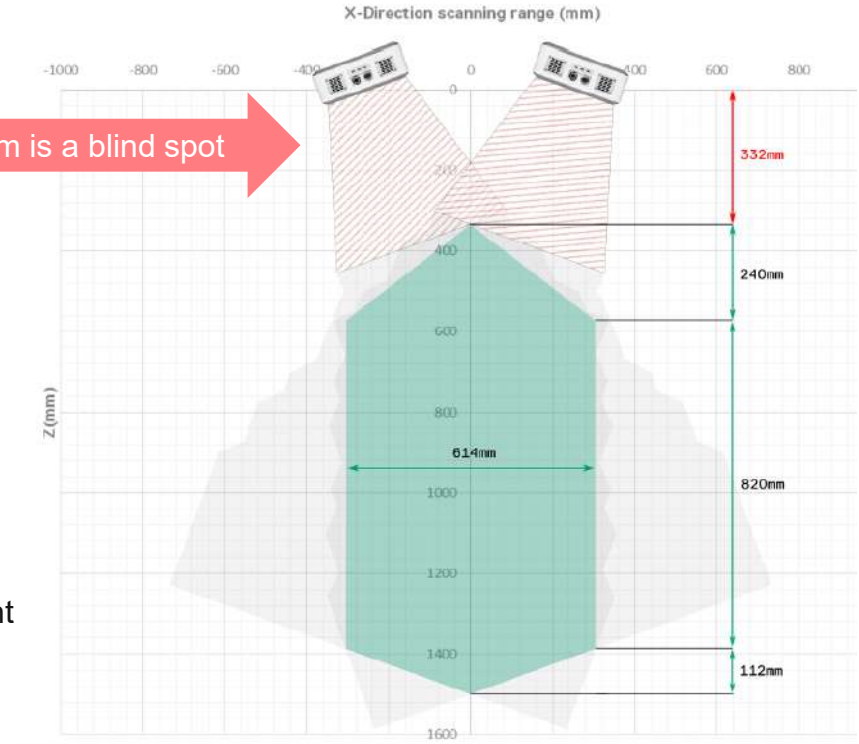
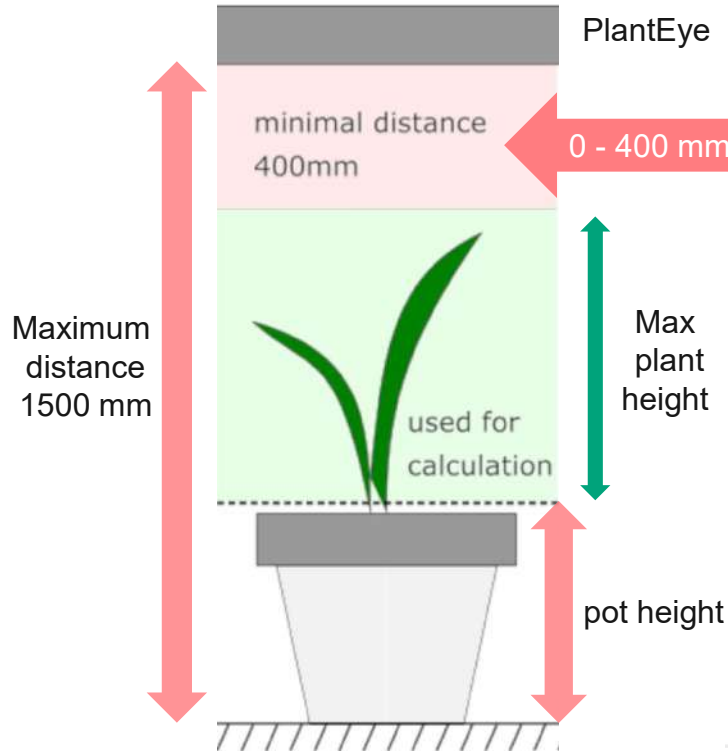
Split

Merge

Calculate



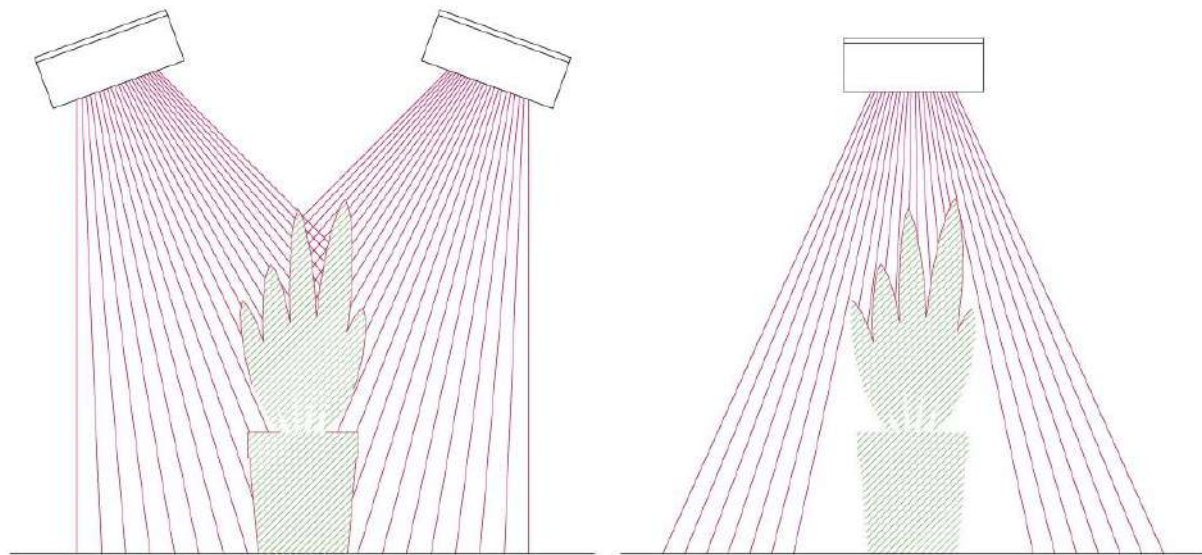
Scanning range



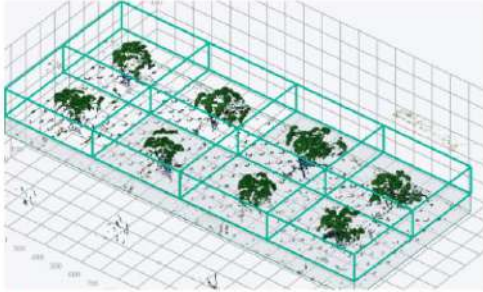
- Resolution decreases with distance
- Field of view becomes wider at farther distances

Why Dual Scan is used?

- ✓ Higher accuracy
- ✓ Fewer shadows or artifacts
- ✓ Better depth perception
- ✓ More complete surface and internal detail



Workflow



1. Setup experiment



2. Scan crops



3. Calculate parameters



4. Results & data management

HORTCONTROL software to setup, visualize and analyze the data



- **Experiment setup, control & monitoring**
- **Data visualization**
- **Plant analysis tools**, e.g. growth analysis, Germination analysis
- **All sensor data Centralized**, PlantEye, DroughtSpotter, Weather Station
- **Correlation & machine learning tools**, Faster validation studies

PLANTEYE DATA BIG DATA sheet as .CSV file

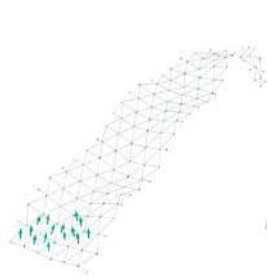
	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P
1	unit	timestamp	genotype	g_alias	treatment	3D Leaf Area mm ²	Canopy Light Penetration D	Convex Hull Area Coverage	Convex Hull Area mm ²	Convex Hull Area Coverage	Convex Hull Area Coverage	Convex Hull Area Coverage	Digital Biom	GLI Average	GLI [-0.5, 0.5]
2	3:01:01	4/9/2024 14:48	93 L01	L01	L01	5353.43	42.9382	31.2006	8301.25	36.8149	400.507	178.607	270790	0.244616	3.67
3	3:01:01	4/9/2024 14:53	93 L01	L01	L01	5422.75	43.2244	32.7802	8441.94	35.2536	402.911	178.62	267004	0.239042	4.26
4	3:01:01	4/9/2024 14:58	93 L01	L01	L01	5348.04	42.8297	33.8061	8373.62	35.5315	400.88	177.949	262030	0.241875	4.24
5	3:01:02	4/9/2024 14:48	93 L01	L01	L01	1756.3	30.4551	20.4266	4642.92	28.5537	311.887	137.979	64469.1	0.164811	6.58
6	3:01:02	4/9/2024 14:53	93 L01	L01	L01	1700.93	25.7792	22.6384	4275.17	25.8195	308.632	139.309	59376.8	0.178246	5.42
7	3:01:02	4/9/2024 14:58	93 L01	L01	L01	2001.52	24.2085	24.6135	4523.81	27.5581	315.135	141.768	62382.8	0.194298	5.27
8	3:01:03	4/9/2024 14:48	93 L01	L01	L01	4531.79	40.4959	13.3584	17134.9	67.52	516.215	186.662	205778	0.216922	4.62
9	3:01:03	4/9/2024 14:53	93 L01	L01	L01	4202.24	38.2635	13.6803	16496.3	73.3017	502.217	184.696	185881	0.215431	5.24
10	3:01:03	4/9/2024 14:58	93 L01	L01	L01	4209.67	35.4793	24.7039	8533.5	48.2006	395.238	164.427	180867	0.214182	5.17
11	3:02:01	4/9/2024 14:48	93 L01	L01	L01	1917.28	51.1764	7.44529	16856.1	48.1327	583.317	231.002	104133	0.247205	4.25
12	3:02:01	4/9/2024 14:53	93 L01	L01	L01	1815.61	51.45	29.5061	4028.75	41.3016	269.144	112.022	98659	0.250067	4.31
13	3:02:01	4/9/2024 14:58	93 L01	L01	L01	1812.54	51.4203	29.4353	3984	40.5557	269.948	113.198	99051.9	0.25405	4.49
14	3:02:02	4/9/2024 14:48	187 L2	L02	L02	6245.8	40.8149	31.7787	10298.9	51.4605	401.758	159.762	339596	0.23881	3.43
15	3:02:02	4/9/2024 14:53	187 L2	L02	L02	6810.53	41.5441	32.5965	10496	51.3166	406.69	162.796	367600	0.234977	3.78
16	3:02:02	4/9/2024 14:58	187 L2	L02	L02	6865.54	41.7181	32.1989	10595.3	52.4797	407.467	162.25	370582	0.236103	3.26
17	3:02:03	4/9/2024 14:48	187 L2	L02	L02	3236.53	40.2776	21.3148	10149.4	75.7771	388.217	132.931	142642	0.229457	5.55
18	3:02:03	4/9/2024 14:53	187 L2	L02	L02	3381.36	42.4059	22.6909	9984.38	71.5018	388.323	133.934	155808	0.230595	5.10
19	3:02:03	4/9/2024 14:58	187 L2	L02	L02	3480.82	42.5343	22.5395	10241.6	74.0254	391.094	134.435	160648	0.231451	5.01
20	3:03:01	4/9/2024 14:48	187 L2	L02	L02	2196.07	25.6759	24.8326	5706.25	47.8945	308.558	120.494	61338.4	0.232947	4.57
21	3:03:01	4/9/2024 14:53	187 L2	L02	L02	2323.16	25.4211	26.4426	5738	47.1474	310.539	121.671	65049.5	0.22914	4.49
22	3:03:01	4/9/2024 14:58	187 L2	L02	L02	2292.34	24.9058	26.394	5731.5	46.6493	310.496	121.824	63242.1	0.229905	4.70
23	3:03:02	4/9/2024 14:48	187 L2	L02	L02	2517.61	38.4924	26.582	5892.3	48.1539	307.366	128.265	103692	0.232868	3.4
24	3:03:02	4/9/2024 14:53	187 L2	L02	L02	2528.77	38.3567	27.2047	5864.59	48.1254	306.922	128.307	104626	0.23159	4.24
25	3:03:02	4/9/2024 14:58	187 L2	L02	L02	2568.88	38.4704	27.847	5803.03	47.616	305.861	128.67	106758	0.232649	3.57
26	3:03:03	4/9/2024 14:48	72 L3	L03	L03	799.279	21.8815	20.4058	2233.5	48.7663	195.494	82.7957	19135.2	0.23308	4.36
27	3:03:03	4/9/2024 14:53	72 L3	L03	L03	846.224	22.7853	19.8285	2232.25	48.647	195.265	82.5845	21320.3	0.225884	3.9
28	3:03:03	4/9/2024 14:58	72 L3	L03	L03	765.138	24.5582	20.6928	2033.75	44.4077	185.645	79.3317	20700	0.23883	4.36
29	3:04:01	4/9/2024 14:48	72 L3	L03	L03	2678.15	29.1504	26.0503	5485.25	81.6268	276.829	97.9159	85463.9	0.198529	5.2
30	3:04:01	4/9/2024 14:53	72 L3	L03	L03	2789.16	29.8202	27.6951	5478	82.108	276.844	98.3195	90777.1	0.194594	5.94
31	3:04:01	4/9/2024 14:58	72 L3	L03	L03	2767.8	29.7322	27.122	5495.5	82.6026	276.78	97.9159	89819.9	0.195191	5.40
32	3:04:02	4/9/2024 14:48	72 L3	L03	L03	1634.49	27.1051	13.5696	7133.91	39.7159	381.096	163.66	48475.6	0.214447	4.84
33	3:04:02	4/9/2024 14:53	72 L3	L03	L03	1761.71	28.3089	14.476	7190.84	39.7191	381.468	164.257	53759.2	0.208651	4.77
34	3:04:02	4/9/2024 14:58	72 L3	L03	L03	1804.26	29.0313	14.899	7314.15	40.6075	381.166	163.593	55774.5	0.206514	5.77
35	3:04:03	4/9/2024 14:48	72 L3	L03	L03	953.13	23.6855	19.8537	2855	67.328	215.766	73.8999	23664	0.216941	4.24

PLANTEYE DATA. Morphological parameters

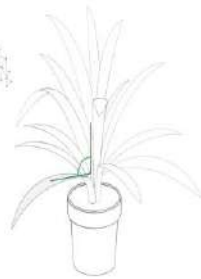
Visualize plant growth with a wide variety of morphological parameters:



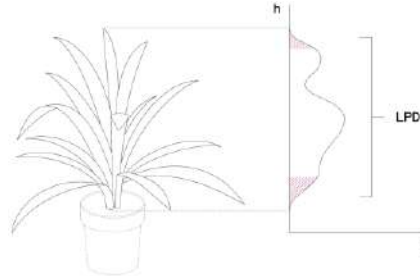
Digital Biomass (mm³)



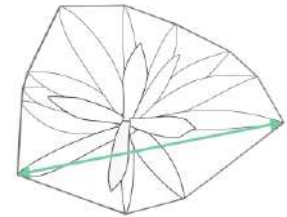
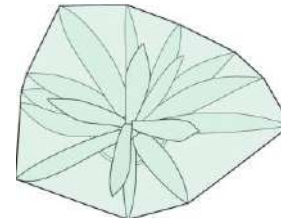
Surface Angle Average (°)



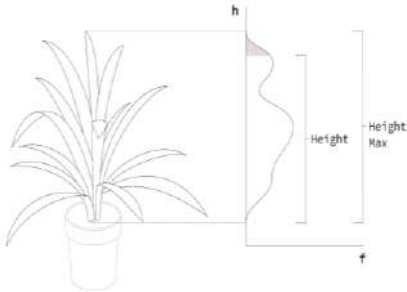
Canopy Light Penetration Depth (mm)



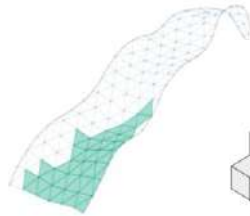
Convex Hull Area (mm²)



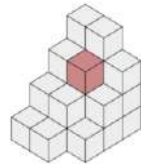
Convex Hull Maximum Width (mm)



Plant Height Max/Average (mm)



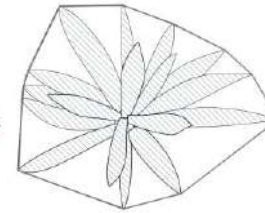
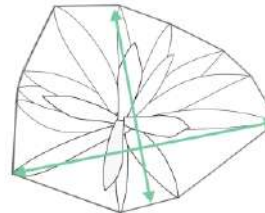
3D Leaf Area (mm²)



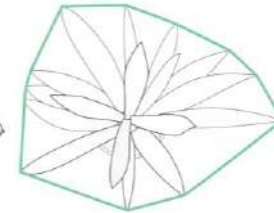
Voxel Volume Total (mm³)



Convex Hull Aspect Ratio



Convex Hull Area Coverage (mm²)



Convex Hull Circumference (mm)

PLANTEYE DATA. Spectral parameters

HUE

0 – 360 °

- Hue represents the type of color and is measured as an angle on the color wheel from 0° to 360°.

Hue is useful for:

- Plant health monitoring
- Detecting leaf color changes
- Vegetation segmentation
- Estimating chlorophyll status

Lightness

0 – 100 %

- Lightness shows how bright the leaf surface appears in the image

Lightness helps with:

- Image analysis and segmentation
- Separating plant from background
- Detecting brightness differences on leaves
- Analyzing plant surface properties

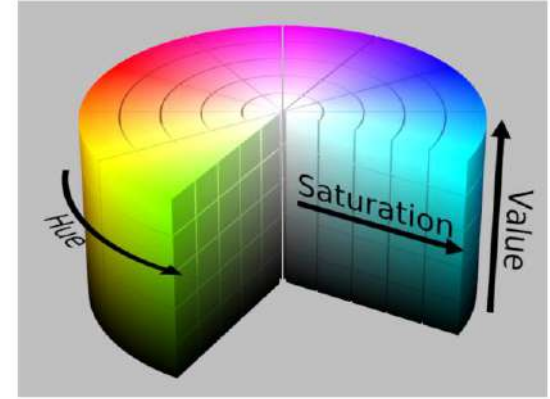
Saturation

0 – 100 %

- Saturation describes how strong or pure a color is.

Saturation used for:

- Plant health monitoring
- Detecting color changes in leaves
- Vegetation segmentation
- Assessing chlorophyll-related color intensity



PLANTEYE DATA. Spectral indices

RGB & NIR Wavelengths are combined into spectral indices:

Normalized Digital Vegetation Index (NDVI)

Value range: -1 to 1

Calculation: $(\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$



-1 - 0
dead plant or
inanimate objects



0 - 0.33
unhealthy plant



0.33 - 0.66
moderately
healthy plant

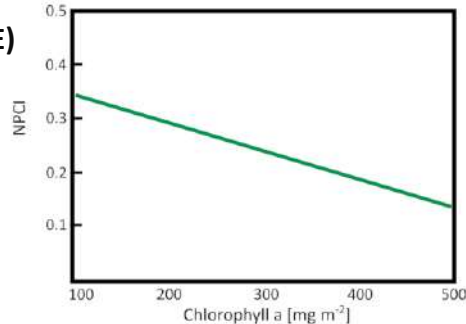


0.66 - 1
very
healthy plant

Normalized Pigments Chlorophyll ratio index (NPCI)

Value range: -1 to 1

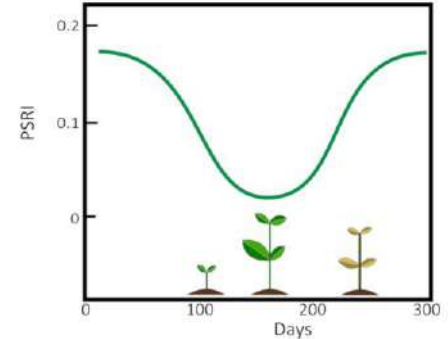
Calculation: $(\text{RED} - \text{BLUE}) / (\text{RED} + \text{BLUE})$



Plant Senescence Reflectance Index (PSRI)

Value range: -1 to 1

Calculation: $(\text{RED} - \text{GREEN}) / (\text{NIR})$



Green Leaf Index (GLI)

Value range: -1 to 1

Calculation: $(2 * \text{G} - \text{R} - \text{B}) / (2 * \text{G} + \text{R} + \text{B})$

-1 - 0

Soil and non-living features



0 - 1

Green leaves and stems

PLANTEYE DATA 3D .PLY file



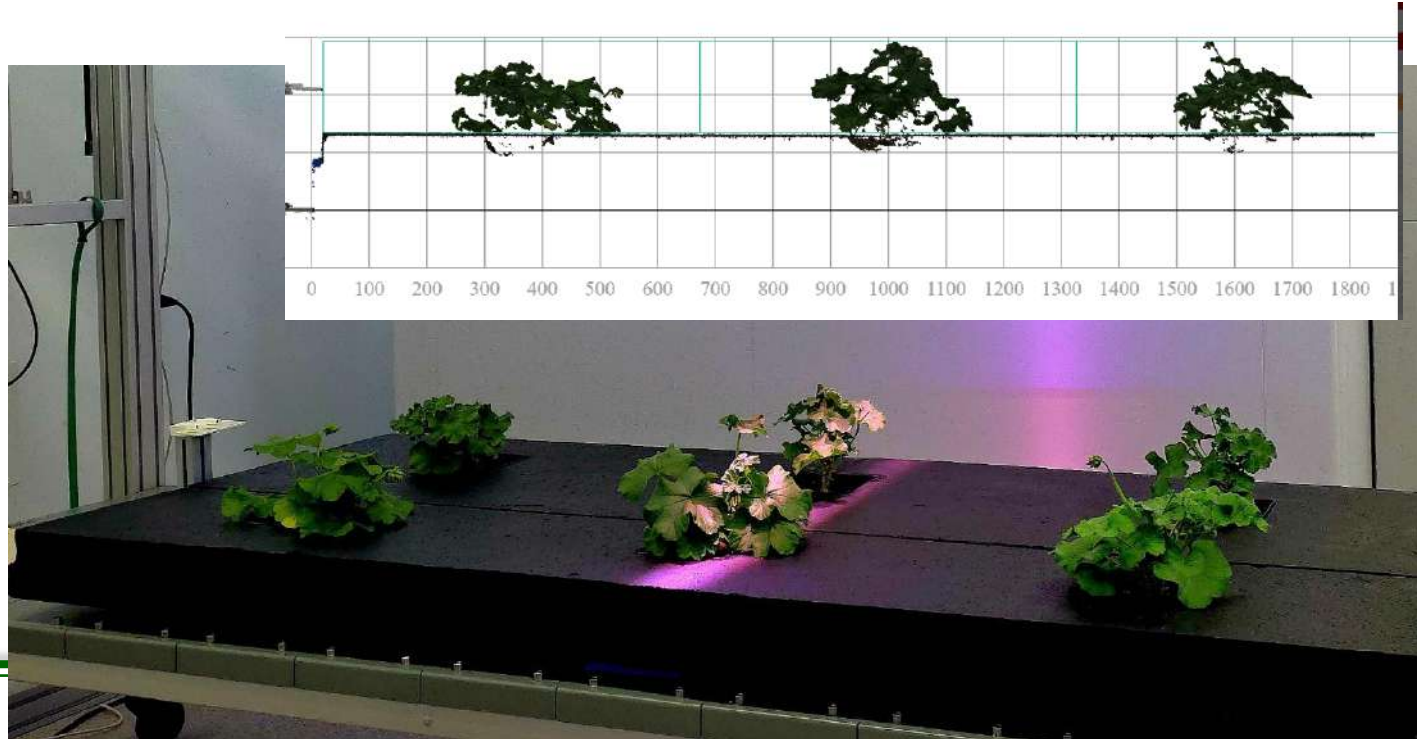
[CloudCompare](https://www.cloudcompare.org/) is a popular open-source 3D point cloud and triangular mesh processing software.



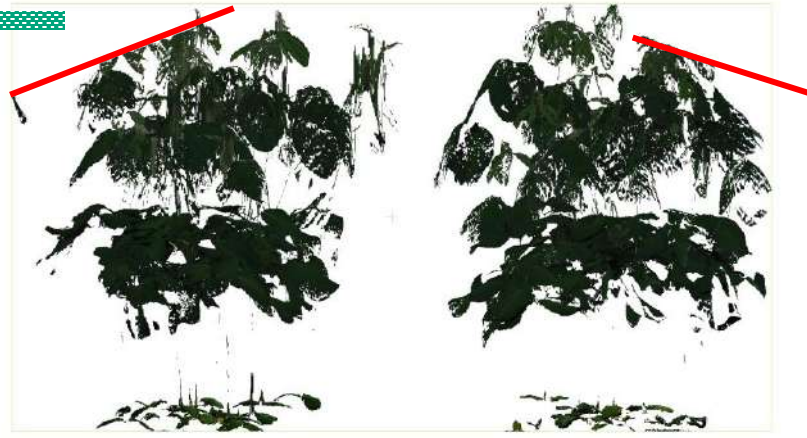
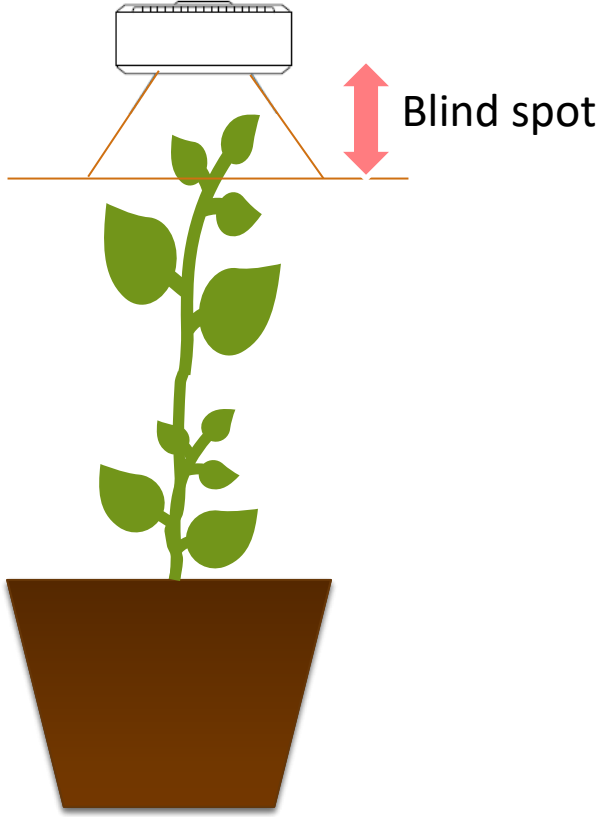


Mistakes & Lessons 1

- Experiment planning is very important: how many scans and frequency, plant size, width and height
- Need to know physiology and development of plant



Mistakes & Lessons 2

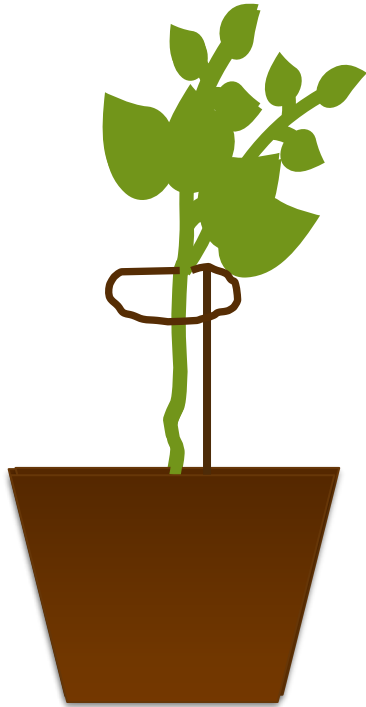


soybeans

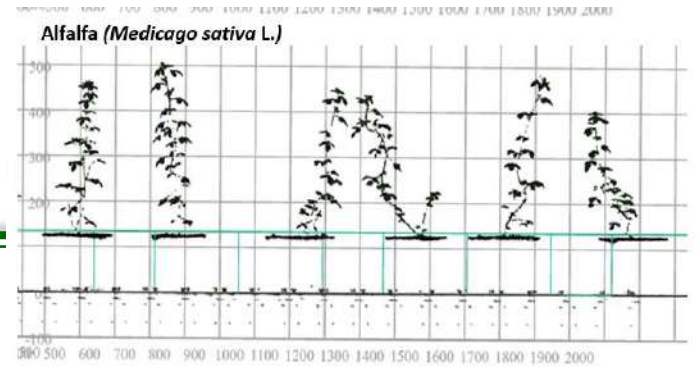
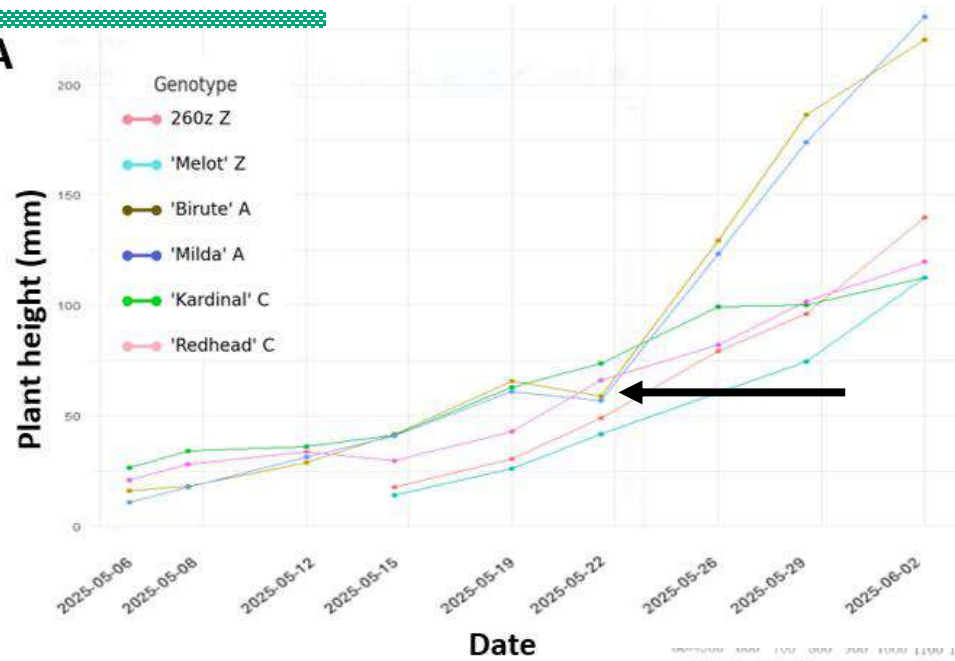


oats

Mistakes & Lessons 3

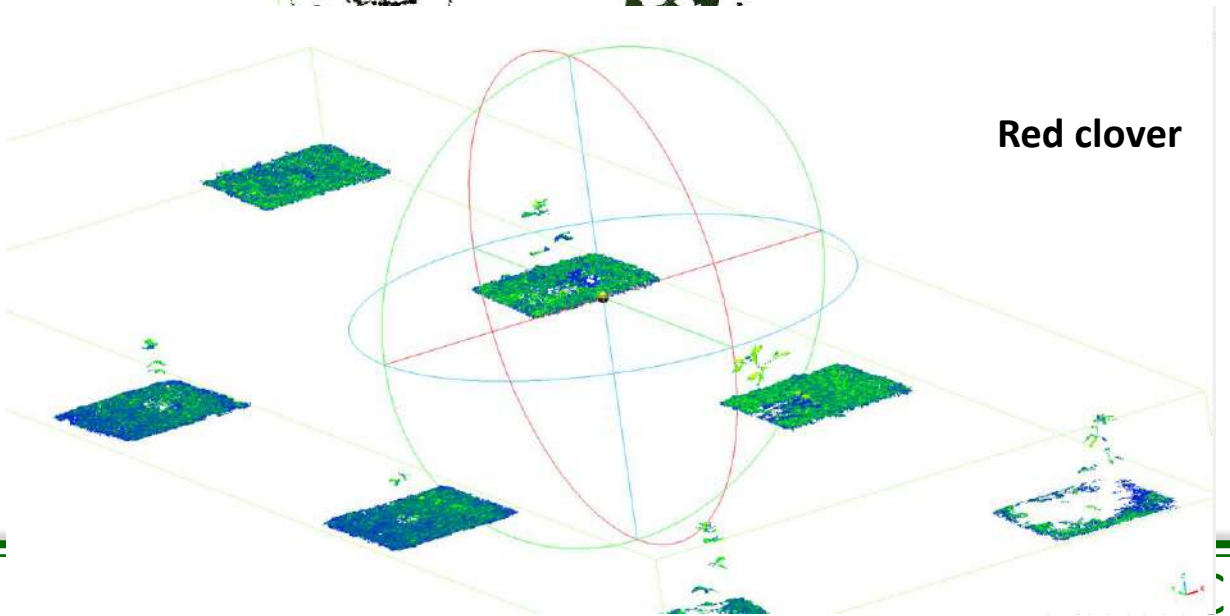


A



Mistakes & Lessons 4

- There are always something unexpected with every ne
- Sowing depth is important
- Too wet soil - algae growth



Red clover

Research example: 1

Biological seed priming responses in clover and alfalfa via 3D multispectral imaging

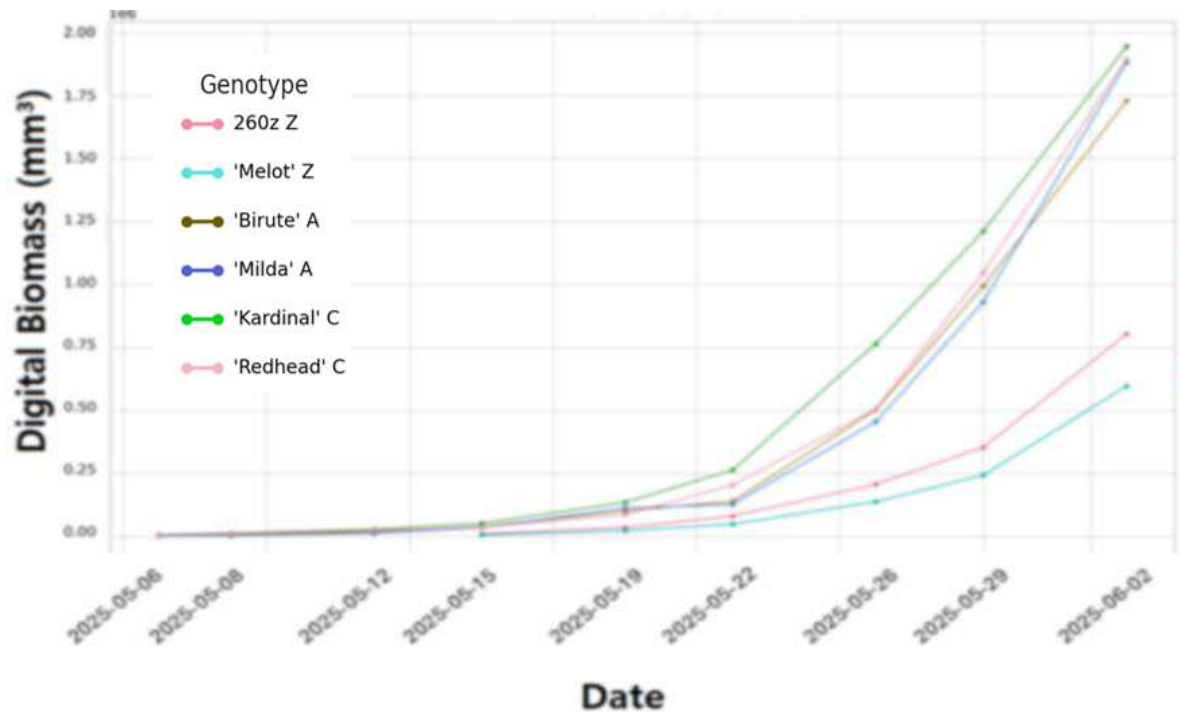


Fig 1. Dynamics of digital biomass between legume genotypes over time.

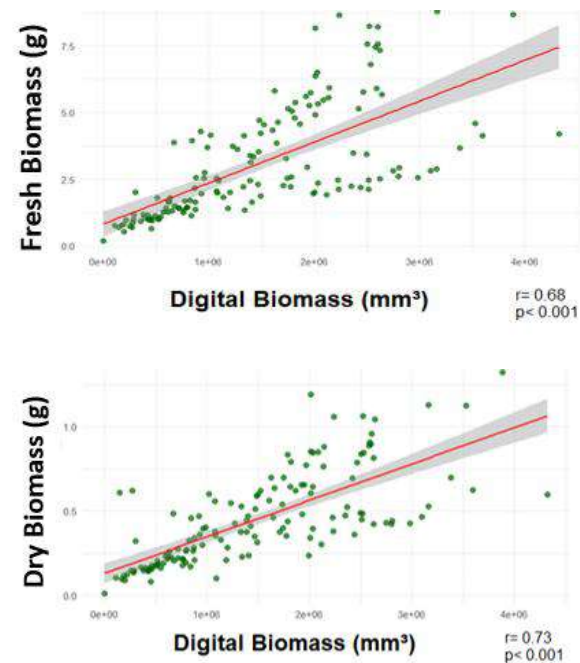


Fig. 3. Pearson's correlation between different biomass types: digital and fresh (A); digital and dry (B);

Research example: 1

Biological seed priming responses in clover and alfalfa via 3D multispectral imaging

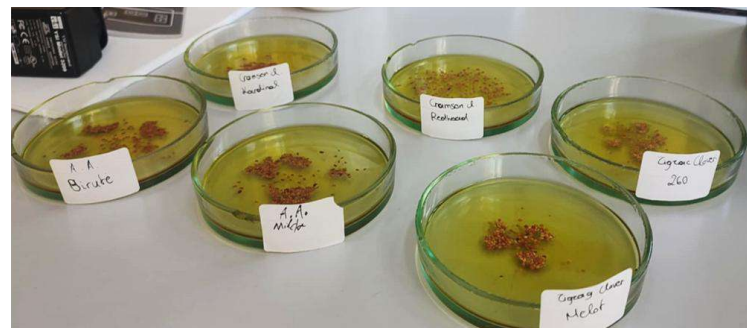
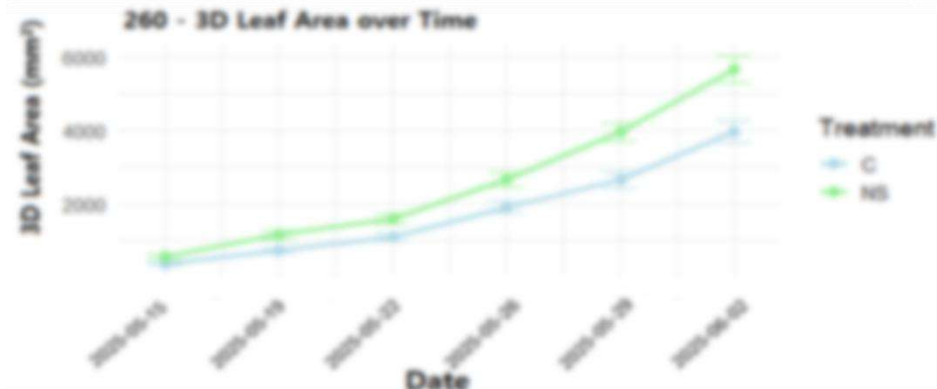
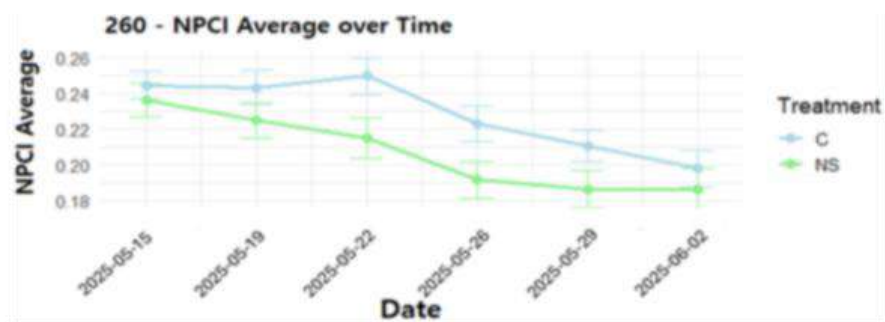
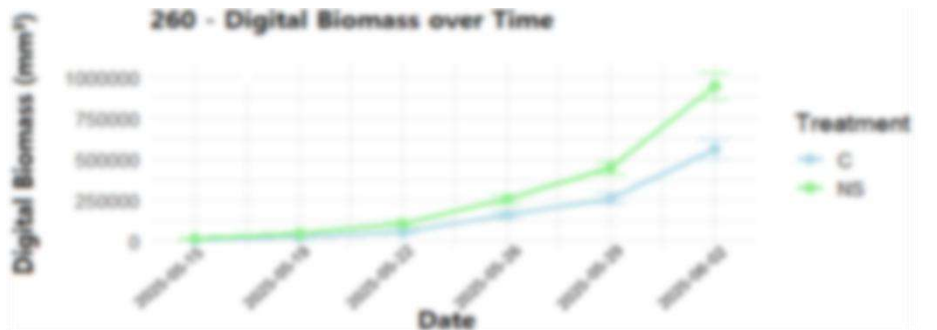


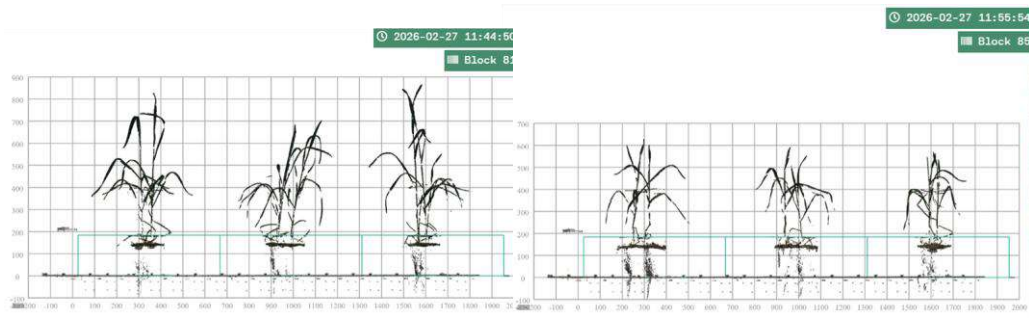
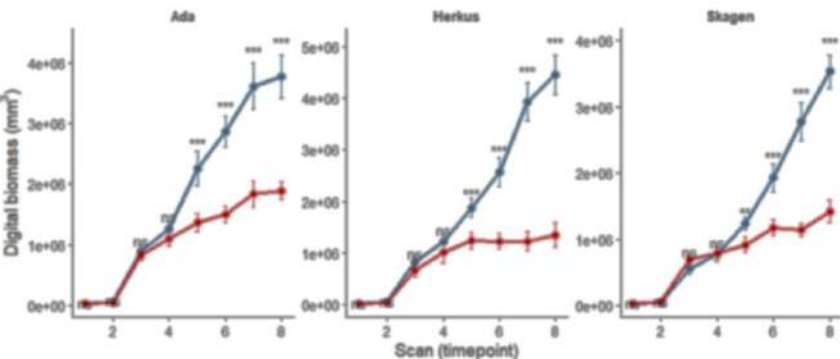
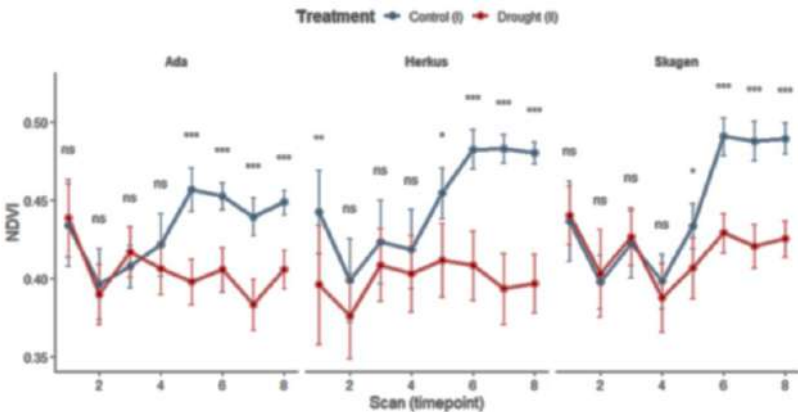
Fig.3. Seeds of all 6 genotypes soaked in NurSeed biostimulant solution.

Research example: 2

Drought-induced changes in the rhizosphere and endosphere microbiome of winter wheat



Egidija Statkevičiūtė
PhD student,



Control (I)

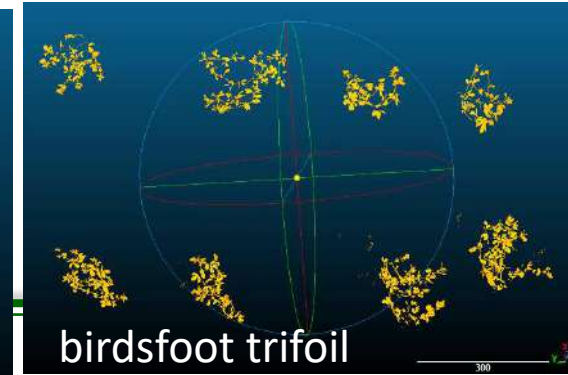
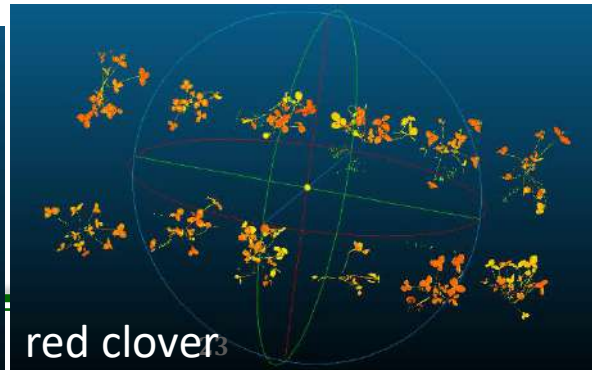
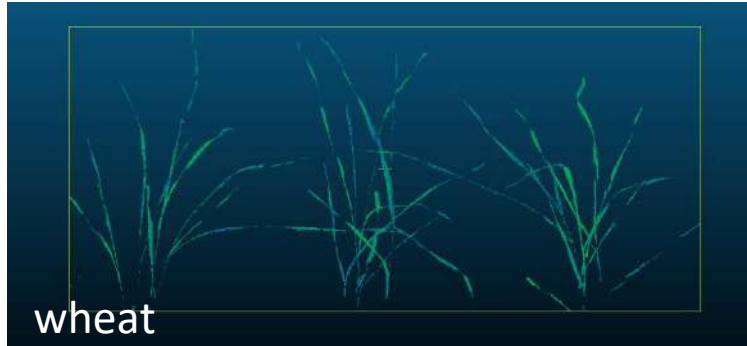
Drought (II)

'Herkus DS' Scan No. 8

Wide range application

PlantEye technology offers versatile applicability across a spectrum of research activities

- Phenotypic/ genotypic variation
- Plasticity to abiotic/biotic stress
- Disease progression, pathogen-plant interaction
- Fungicide, herbicide effectiveness
- Effect of various chemical components, biostimulants



Pros&Cons (From a User Point of View)

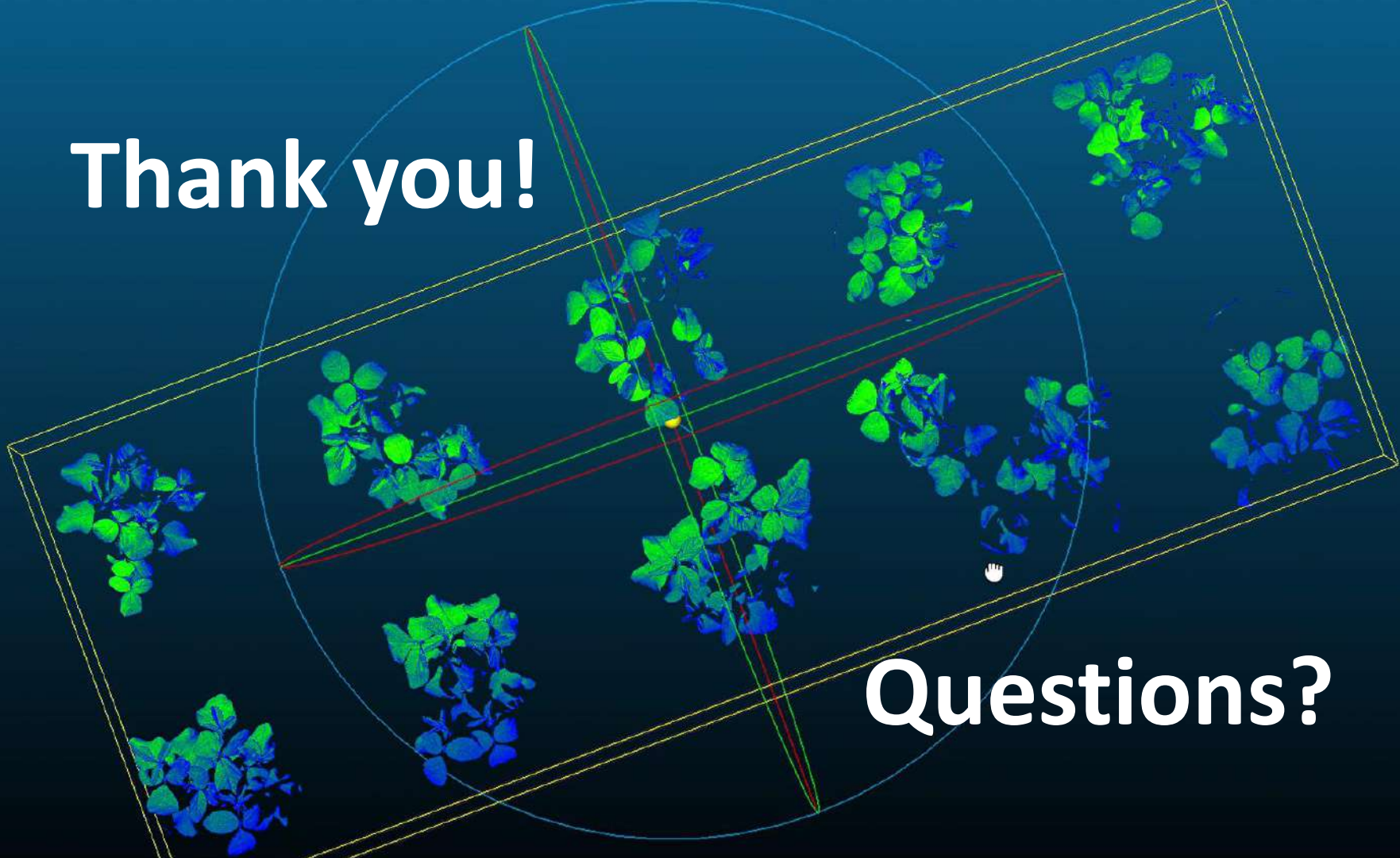
Pros

- Enables tracking of plant growth dynamics over time
- Non-destructive measurement method
- User-friendly system with automatically calculated parameters
- Easy and fast scanning process
- If the system is not installed in a single unit, multiple scans can be performed for different experiments
- Clear 3D representation of plant structure
- Affordable system suitable for smaller institutions
- Effective tool for teaching and student training

Cons

- To set experiment takes time
- Hortcontrol operates somewhat slowly
- Need some solutions for bending plants do not loose data
- For large plant setups, there is still a lot of hands-on work required
- Limited size of plant

Thank you!



Questions?



Introduction to PHIS

Phenotyping Hybrid Information System

Farzaneh Kazemipour-Ricci farzaneh.kazemipour@inrae.fr

Data management workshop – From Phenotyping Experiment to FAIR Data
11-13 March 2026



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Introduction to Phenotyping Hybrid Information System (PHIS)
Data Management Workshop 11-13 March 2026



Phenome-EMPHASIS ecosystem

National platforms dedicated to High Throughput Plant Phenotyping

A national network...



Phenome-EMPHASIS ecosystem

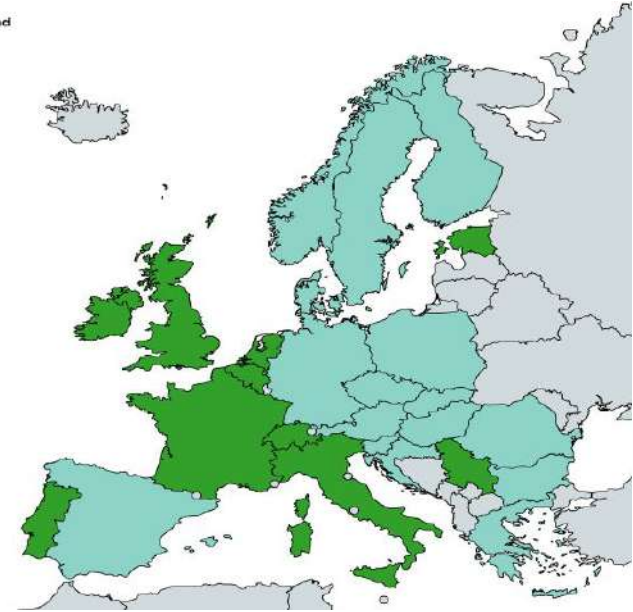
EMPHASIS

European Plant phenotyping Network

...part of an European Network

- 10 countries support the development of EMPHASIS
- 15 additional countries are interested in plant phenotyping: EMPHASIS Support Group
- Mission: facilitate multi-scale plant phenotyping, providing access to facilities, services and resources
- The international organisation coordination is in Belgium
- Phenome-Emphasis, as French node, will co-coordinate the Functional Unit DATA

PHASIS Members and
Reporters
IGA Members
Supporters



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Phenomics Data Challenge

Plant Phenomics Experiments

- Expensive, require a lot of resources and often very hard
- Cannot be reproduced
- Huge and complex datasets
- Open Science research (transparency & Open Data)
- Think FAIR



Make FAIR data! How to do it?

What do we need?

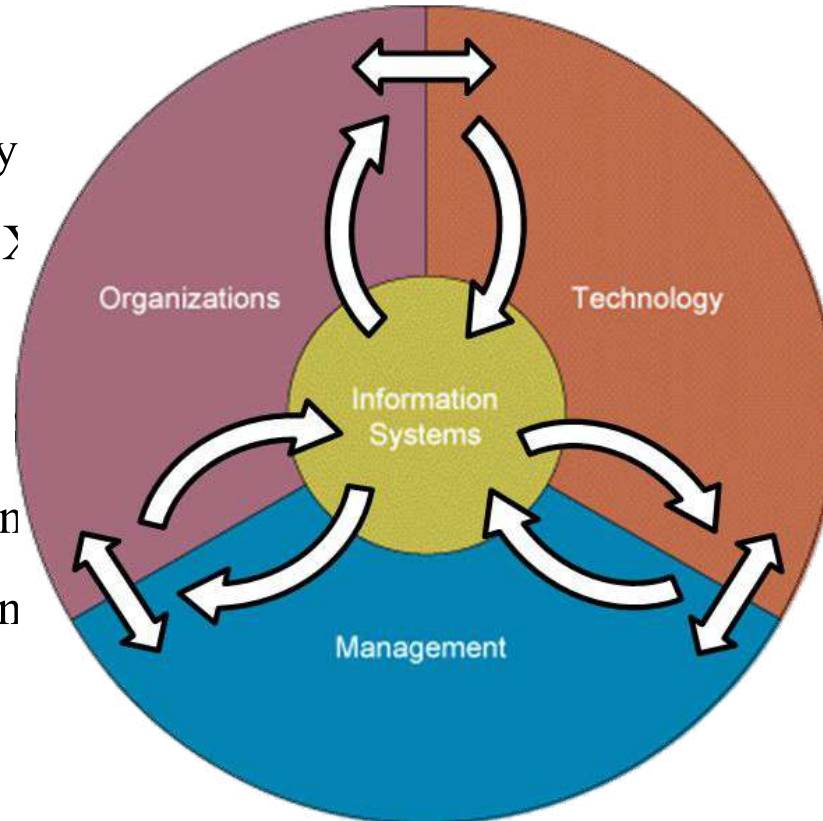
- ❖ Data base management system (SGBD, NoSQL, RDF storage, etc)
- ❖ Representation language XML or JSON
- ❖ Standards (MIAPPE)
- ❖ Access (Web pages, Web Services)
- ❖ Knowledge representation : (ontology, thesaurus, taxonomy, etc.)
- ❖ Analysis and visualisation tools (R, python, etc.)



Make FAIR data! How to do it?

What do we need?

- ❖ Data base management system
- ❖ Representation language
- ❖ Use standards
- ❖ Access (Web pages, Web services)
- ❖ Knowledge representation
- ❖ Analysis and visualisation



PHIS and beyond: OpenSILEX family



Plant Phenotyping



OpenSILEX



Annual crops
Systems trials
Arboriculture - vines

Agro-Ecology



Environment & Processes



Viticulture Oenology

Vitis Explorer



Sinfonia

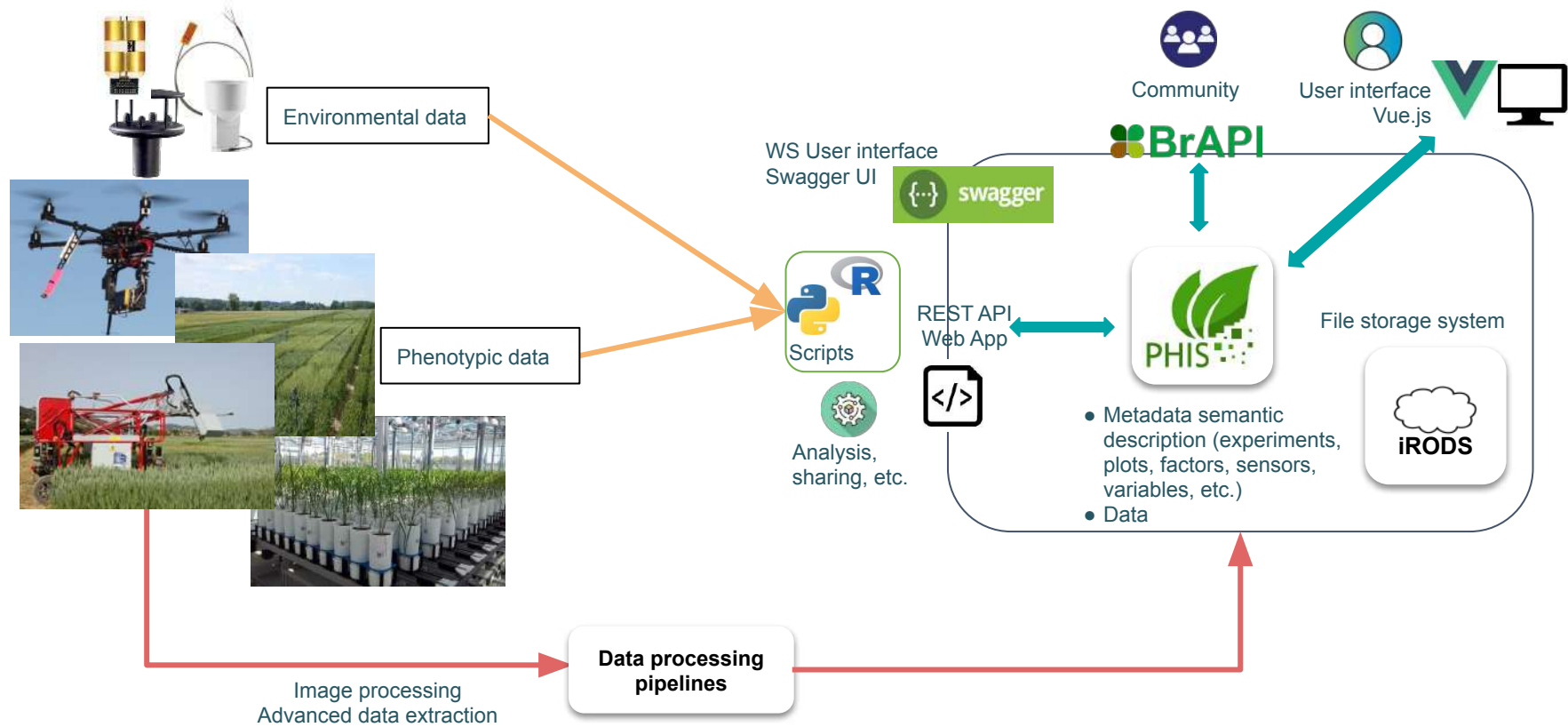


VitiOeno

Instance Ressources

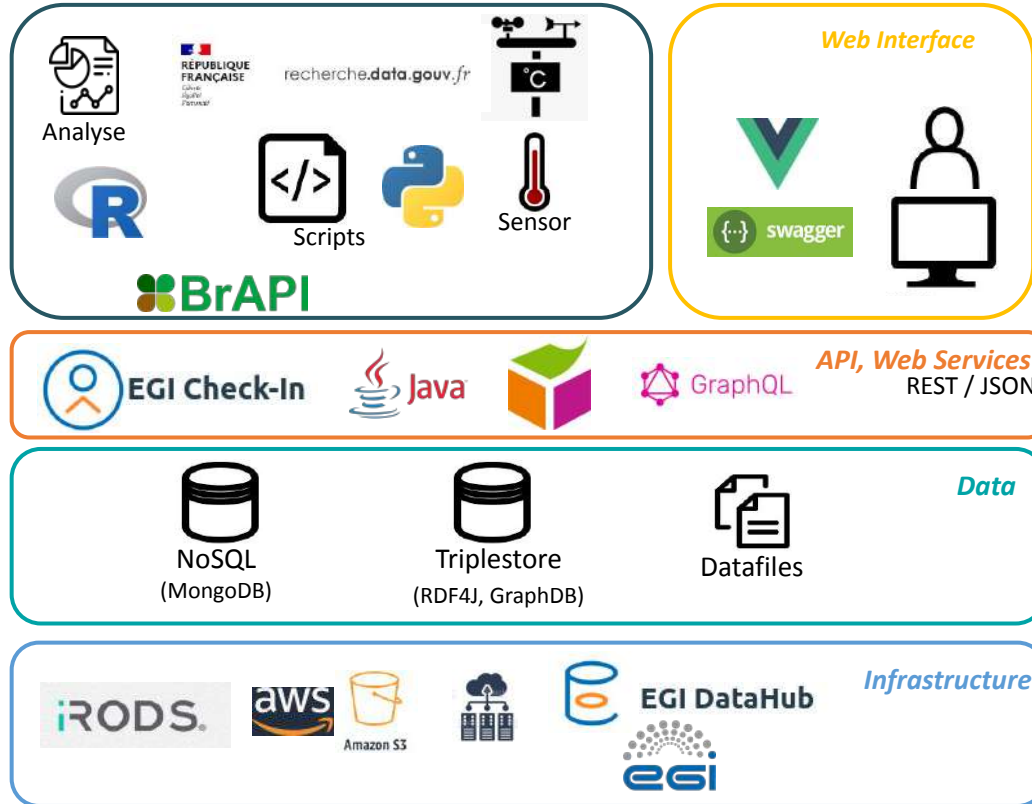
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PHIS: an Ontology driven Information System for Plant Phenomics



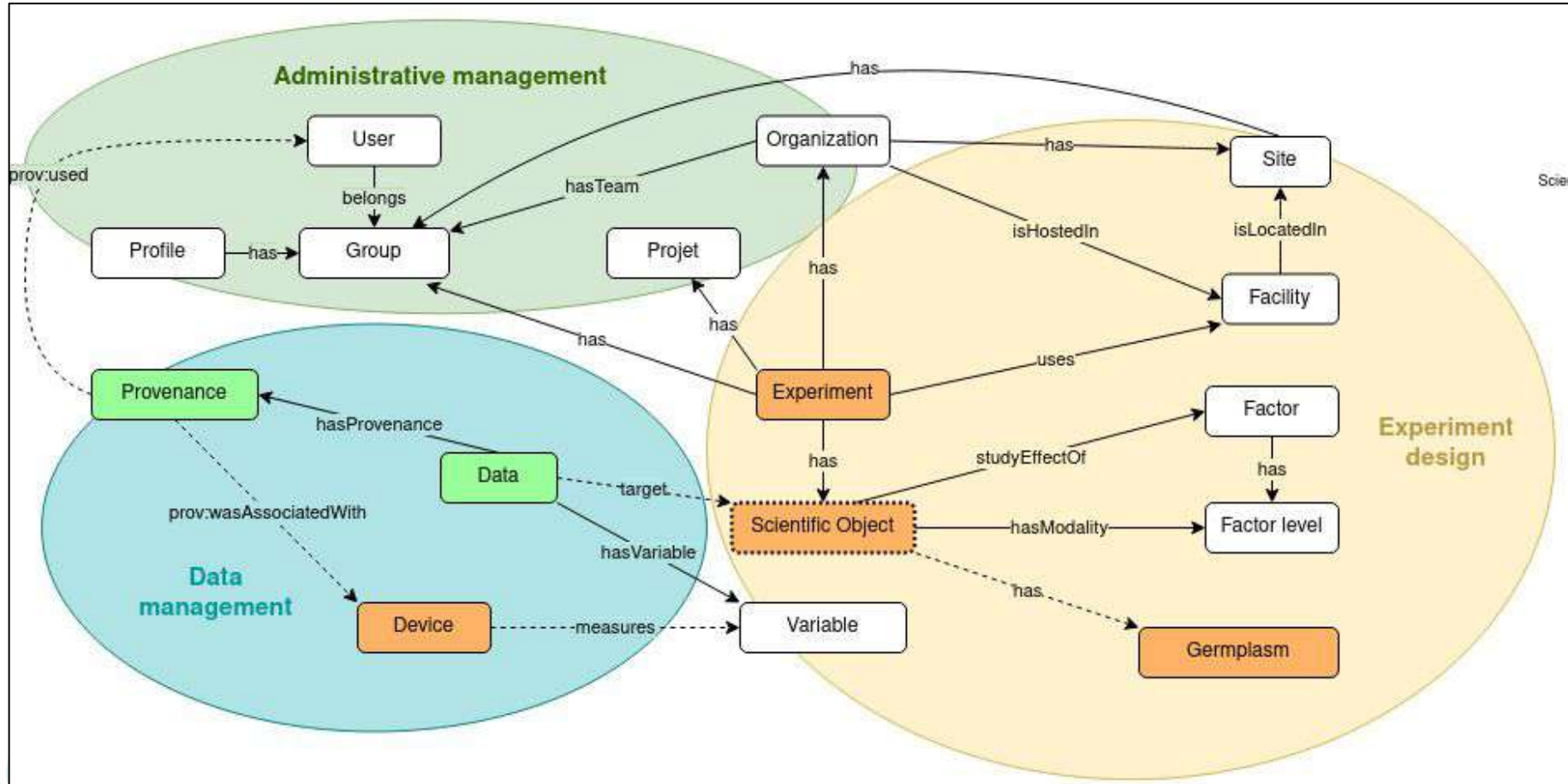
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PHIS and beyond: OpenSILEX Architecture (Software)



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PHIS and beyond: OpenSILEX Architecture (Data Management)



PHIS : An ontology driven approach

- **Scientific objects** (plants, plant organs, plots, etc.)
Identified by URI
- **Events** (management, failures, weather, etc..)
Identified by URI
- **Variables, Documents, Observations and Softwares** are associated with these Objects and Events. Identified by URI
- **Data hierarchy and links** are done using controlled semantics (ontology references, vocabularies, thesauruses, taxonomies), application Ontologies and semantic web languages (RDF, OWL, SKOS)





❖ Standard ontologies

- **time Ontology:** formalizes concepts related to time
- **SOSA:** formalizes concepts related to sensor
- **annotation ontology (ao):** formalizes concepts related to annotation
- **dublin core (dc):** formalizes concepts related to documents
- **foaf:** formalizes concepts related to persons



❖ Domain ontologies

- **Crop Ontology**
- **Agro ontology, PPEO (MIAPPE)**
- **PlantOntology + TO + PATO**
- **Unit Ontology**
- **Envo, etc.**



❖ Application ontologies

- **oeso: Ontology of Experimental Scientific Objects (entities) (GitLab access)**
- **ELOA : Experiment on Living Organisms in Agriculture ontology**
oepp: Ontology of Experimental Phenotypic Objects
main concepts: experiment objects, qualities, experimental information
- **oeev**: ontology of experimental events
main concepts: move, device management, object management, faults, etc.



PHIS and standards - BrAPI



BrAPI - <https://brapi.org/>

- Standardized RESTful web service API specification for communicating plant breeding data
 - **BrAPI-Core - Organization and management:** Programs, Trials, Studies, Locations, People, and Lists
 - **BrAPI-Phenotyping - Entities related to phenotypic observations:** Observation Units, Observations, Observation Variables, Traits, Scales, Methods, and Images
 - **BrAPI-Genotyping - Entities related to genotyping analysis:** Samples, Markers, Variant Sets, Variants, etc.
 - **BrAPI-Germplasm - Entities related to germplasm:** Germplasm Attributes, Seed Lots, etc.

➤ PHIS: BrAPI WebServices implemented

Method	Endpoint	Description
GET	/brapi/v1/calls	Check the available BrAPI calls
GET	/brapi/v1/germplasm	Submit a search request for germplasm
GET	/brapi/v1/studies	Retrieve studies information
GET	/brapi/v1/studies-search	Retrieve studies information
GET	/brapi/v1/studies/{studyDbId}	Retrieve study details
GET	/brapi/v1/studies/{studyDbId}/observations	Get the observations associated to a specific study
GET	/brapi/v1/studies/{studyDbId}/observationunits	List all the observation units measured in the study.





PHIS and standards - MIAPPE

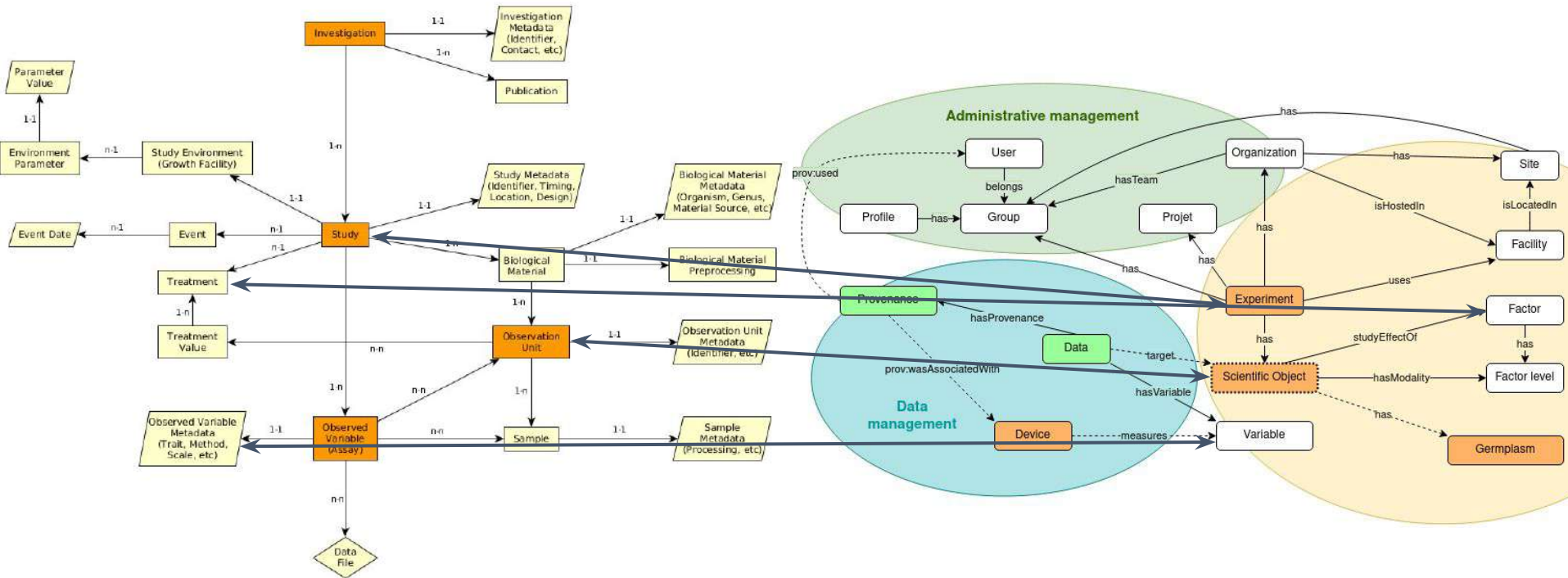


- ❖ MIAPPE - <https://www.miappe.org/>
 - Minimum Information About Plant Phenotyping Experiments
 - Open, community driven, data standard designed to harmonize data from plant phenotyping experiments
 - Mapping with other standards (ISA-Tools , BrAPI)
 - PHIS is MIAPPE-compliant





PHIS and standards - MIAPPE

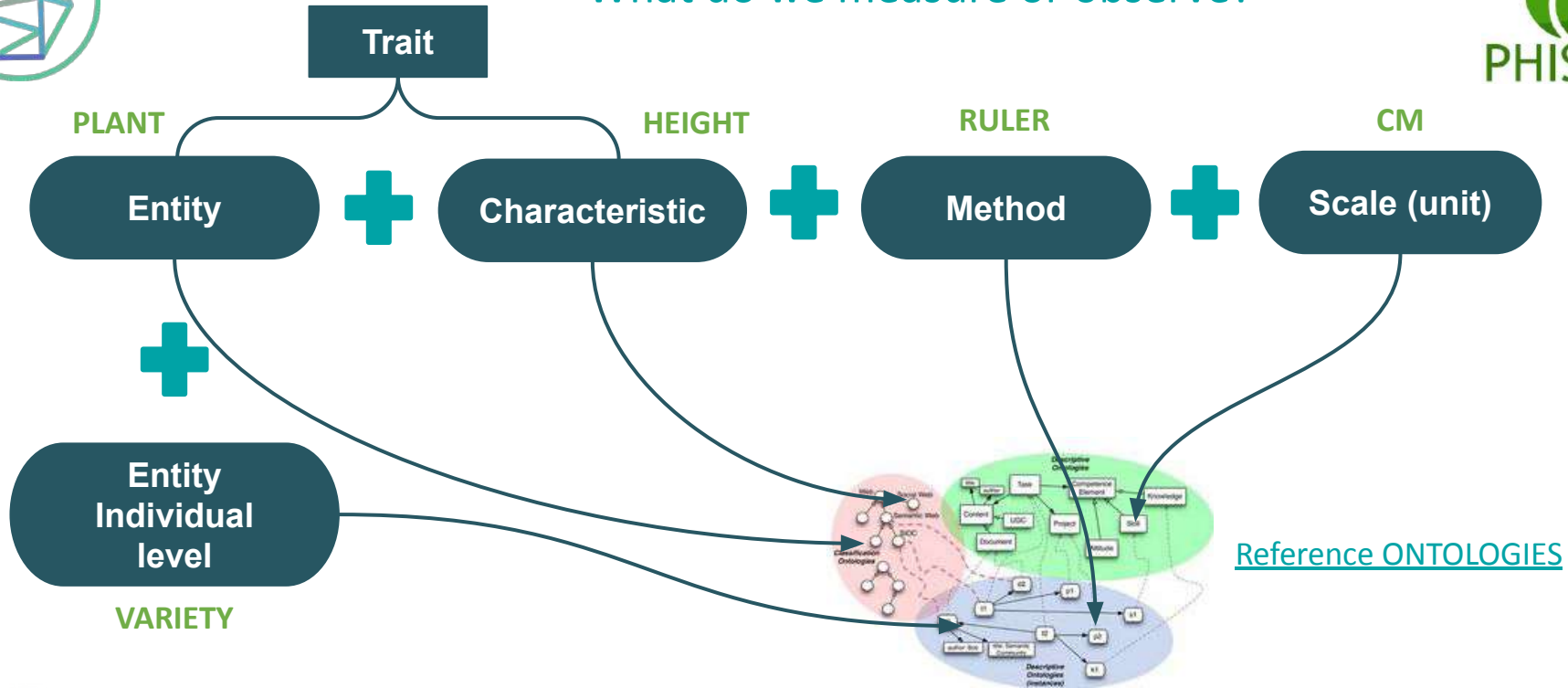


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Variable model : standardized (shared resources)



What do we measure or observe?

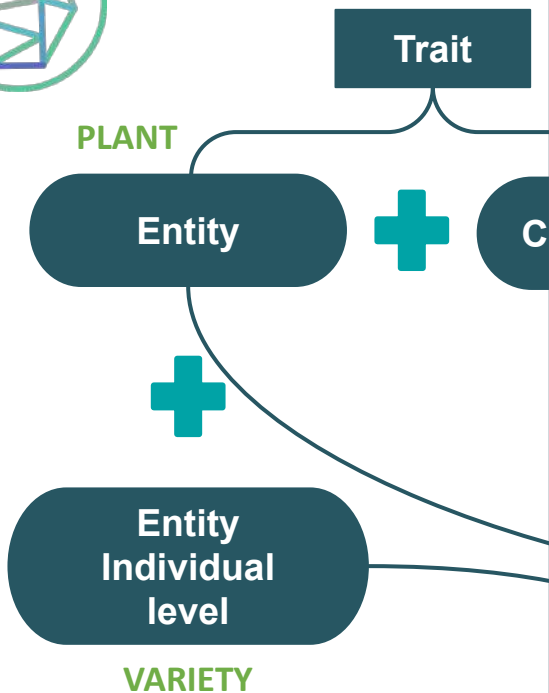


Reference ONTOLOGIES



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PHIS-OpenSILEX: variab



Add variable

URI

autogenerated URI

Entity [?]*

Plant x +

Characteristic [?]*

Height x +

Method [?]*

Ruler x +

Unit/Scale [?]*

Centimeter x +

Observation level [?]

Search and select an observation level x +

Species

Select species x

⚠ Trait already existing in an ontology

Name *

Plant_Height_Ruler_centimeter

Alternative name

Plant_Height

Data type [?]*

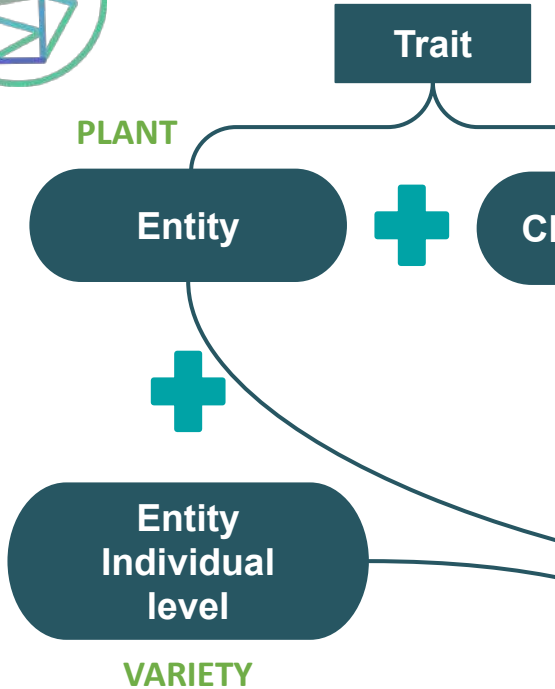
Decimal number x

Time interval [?]

Select an interval x

Sample interval [?]

PHIS-OpenSILEX: variable



Add variable

URI

autogenerated URI

Entity [?]*

Plant

Characteristic [?]*

Height

Method [?]*

Ruler

Unit/Scale [?]*

Centimeter

Name *

Plant_Height_Ruler_centimeter

Data type [?]*

Decimal number

Add trait

Trait uri [?]*

Height

Trait name [?]*

http://purl.obolibrary.org/obo/PATO_0000119

Cancel Save

Select species

Trait already existing in an ontology

Alternative name

Plant_Height

Time interval [?]

Select an interval

Sample interval [?]

PHIS-OpenSILEX: Variable sourcing and sharing

Link these elements to existing ontologies

Agroportal, The home of ontologies and semantic artefacts in agri-food and related domains.- <http://agroportal.lirmm.fr/>

The image displays two screenshots of the AgroPortal website. The left screenshot shows the 'Browse' page, which includes a search bar, a 'Submit New Ontology' button, and a list of ontologies. The right screenshot shows the 'AGROVOC' ontology details page, which includes a tree view of concepts and a table of properties.

AgroPortal Browse Search Mappings Recommender Annotator Projects Landscape Login Support

Browse

Browse the library of ontologies ?

Search... Showing

Submit New Ontology

Entry Type

- Ontology (150)
- Ontology View (11)

Uploaded in the Last

AGROVOC (AGROVOC)

An RDF vocabulary for describing the basic structure and content of concept schemes such as thesauri, classification schemes, subject heading lists, taxonomies, folksonomies, and other types of controlled vocabulary, and also concept schemes embedded in glossaries and terminologies.

Uploaded 11/3/23

Common Greenhouse Ontology (CGO)

This ontology is based on the SSN Ontology by the W3C Semantic Sensor Network Incubator Group (SSN-XG), together with considerations from the W3C/OGC Spatial on the Web Working Group

AGROVOC Last updated: November 3, 2023

Summary Concepts Properties Notes Mappings Schemes Collections Widgets

Jump to Filter

Details Visualization Notes (0) Concepts Mappings (125) Access Concepts JSON

ID	http://aims.fao.org/zoos/agrovoc/c_61f3cae5
Preferred Name	plant height
Synonyms	bitki yuksekligi
Definitions	http://aims.fao.org/zoos/agrovoc/r/Def_e04b7d8b
In Schemes	AGROVOC
Type	http://www.w3.org/2004/02/skos/core#Concept



PHIS-OpenSILEX: Genetic resources (Germplasm)

Accession

PHIS \neq GenBank, Genetic DataBase, catalog, etc.

General information

URI	https://doi.org/10.15454/G4PBP/A
Type	Accession
Name	ADAM
Code	783
Institute	GDEC - UMR Génétique, Diversité et Ecophysiologie des Céréales
Web site	https://urgi.versailles.inrae.fr/insidare/
Description	Accessions CRB_Cereal a paille
Species	bread wheat http://www.itsa.bio.org/wiki/agrevoc0c_7951

SeedLot

General information

URI	https://www.geves.fr/catalogue/variete/1023444-adevey/
Type	Seed Lot
Name	Adevey_9051217
Species	Maize http://amr.cas.org/agrevoc0c_8504
Variety	Adevey https://www.geves.fr/catalogue/variete/1023444-adevey/

https://www.geves.fr/catalogue/variete/1023444-adevey/Adevey_9051217



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Data Management Workshop 11-13 March 2026

Otherwise? Follow the conventional model to create URI:
http://Hordeum_Vulgare/Tyra/21CMLBB

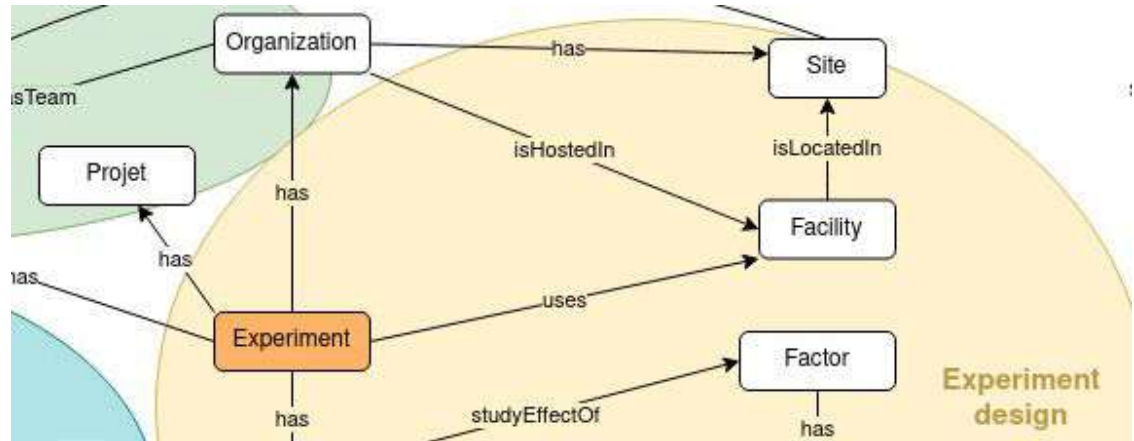


PHIS-OpenSILEX: Experiment structure and its scope



PHIS Interfaces allow to manage:

- **Scientific Organization**
 - Project information
 - Experimental context
 - Facilities
 - Sensors



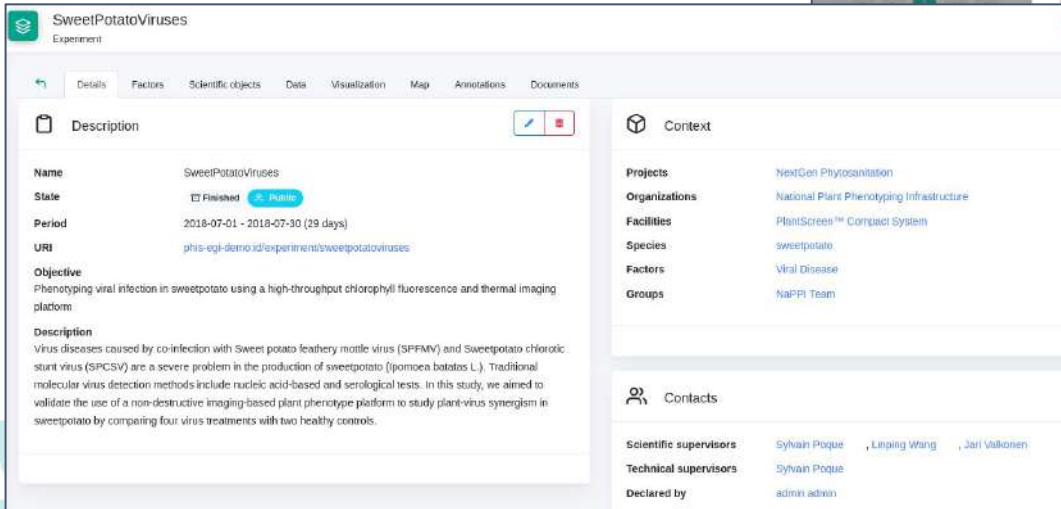
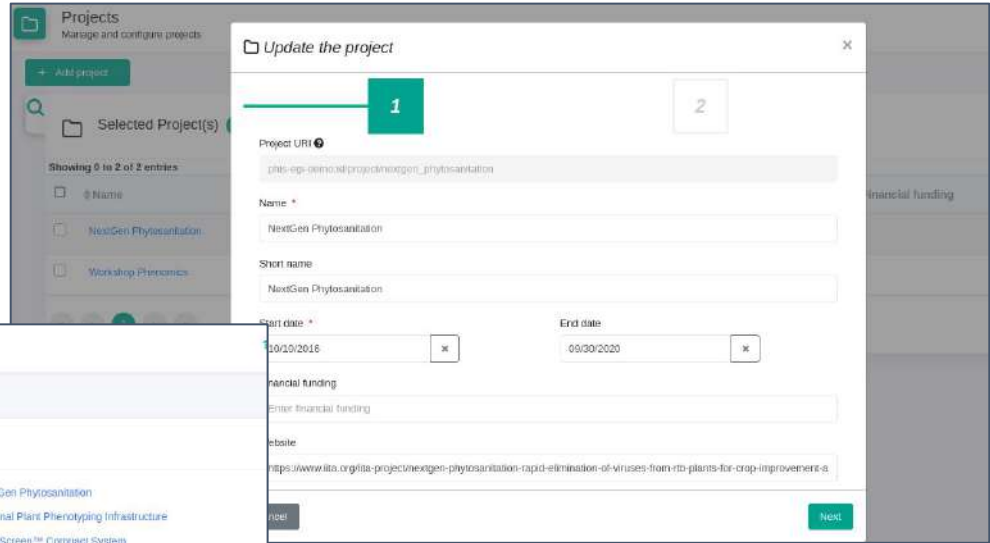


PHIS-OpenSILEX: Experiment structure and its scope



PHIS Interfaces allow to manage:

- **Scientific Organization**
 - Project information
 - Experimental context
 - Facilities
 - Sensors





PHIS-OpenSILEX: Experiment structure and its scope



PHIS Interfaces allow to manage:

- **Scientific Organization**
 - Project information
 - Experimental context
 - Facilities
 - Devices
 - Sensors

The screenshot shows the PHIS 'Organizations' management interface. The sidebar on the left contains navigation options: Scientific Organization, Organizations, Projects, Experiments, Facilities, Devices, Events, Scientific Information, Data, Vocabulary, and Administration. The main content area is titled 'Organizations' and 'Manage and configure organizations'. It features a search bar and a tree view of organizations and sites. An 'Update facility' modal window is open, displaying the following fields: Object URI (phs-epi-demo-organization/facility/plantscreen_modular_system), Type (Greenhouse), Name (PlantScreen™ Modular System), Organizations (National Plant Phenotyping Infrastructure), Site (Search and select a facility), and Address (checkbox). The modal has 'Cancel' and 'OK' buttons at the bottom right.



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PHIS-OpenSILEX: Experiment structure and its scope



PHIS Interfaces allow to manage:

- **Scientific Organization**
 - Project information
 - Experimental context
 - Facilities
 - Sensors

The screenshot displays the PHIS web interface. On the left is a navigation sidebar with categories like 'Scientific Organization', 'Scientific Information', 'Data', 'Vocabulary', 'Administration', 'Tools', and 'Web API'. The main content area is titled 'Device Manage Device' and features a search bar and a list of 'Selected devices'. A modal window titled 'Update device' is open, showing a form with the following fields:

- URI: `http://phis.mim.helsinki.fi/devices/compact_topview_rgb2`
- Type: `RGB camera`
- Name: `Compact_TopView_RGB2`
- Description: (empty text area)
- Brand: `IDS Imaging Development Systems GmbH`
- Constructor model: `GigE uEye UI-5580SE-C/M - 5 Megapixels QSXGA Camera with 1/2" CMOS Sensor (MT9P006STC)`
- Serial number: (empty text field)

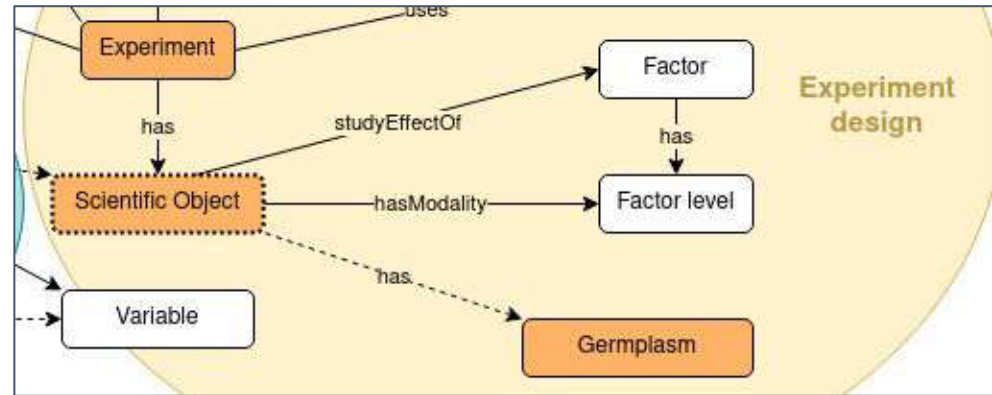


PHIS-OpenSILEX: Experiment structure and its scope



PHIS Interfaces allow to manage:

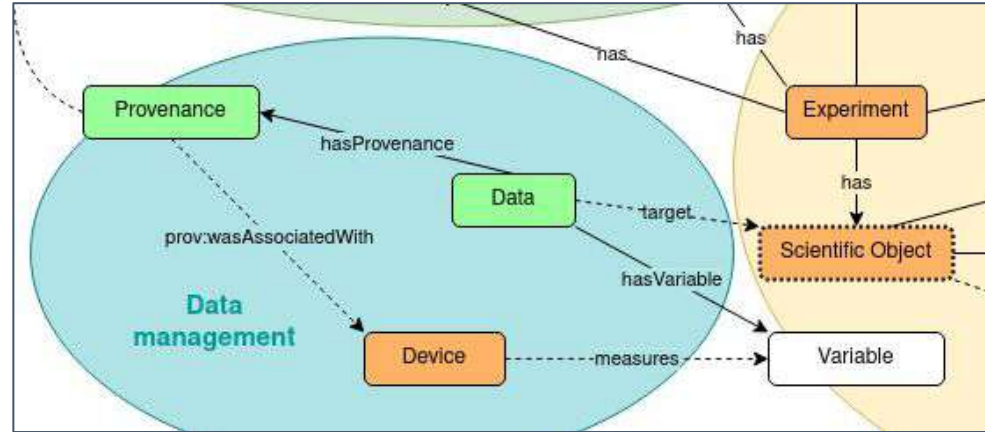
- **Scientific Organization**
 - Project information
 - Experimental context
 - Facilities
 - Sensors





PHIS Interfaces allow to manage:

- **Data**
 - Tabular data
 - Data files
- Data visualization
- Data provenance
- Datafile management



PHIS-OpenSILEX: Measurements & Observations

The screenshot displays the PHIS-OpenSILEX Data Management interface. The left sidebar contains navigation options: Scientific Organization, Scientific Information, Data, Tabular Data (selected), Data files, Provenances, Events, Documents, Spatial, Vocabulary, Administration, About, Tools, Open science, and Web API. The main content area is titled 'Data' and includes a 'View and export data' link. A notification banner at the top right states 'Upgrade to version 1.4.1 in January 2025'. Below this, there are buttons for '+ CSV Import' and 'Export'. A search bar for 'Variable(s)' is present, with a dropdown menu showing 'Experiment(s)', 'Scientific object(s)', 'Germplasm Group', 'Germplasm', 'Devices', 'Operators', and 'Facilities'. The main data table shows a list of measurements with columns for Target, Date, Variable, Value, Provenance, and Actions. Three columns (Target, Date, and Variable) are highlighted with red boxes. The table contains 20 entries, with the first row showing a measurement for 'MA4 (agricultural plot)' on '2025-09-15T08:52:57.000Z' with a value of -72 for the variable 'soil_waterPotential_measurement_kilopascal'.

PHIS

Data
View and export data

Upgrade to version 1.4.1 in January 2025

+ CSV Import Export

Variable(s)
Select one or more variables >>

Experiment(s)
Select one or more Experiments

Scientific object(s)
Select scientific objects >>

Germplasm Group
Select one germplasm group

Germplasm
Select one or more germplasm >>

Devices
Search and select devices

Operators
Search persons...

Facilities
Search and select a facility

Showing 1 to 20 ...

Target	Date	Variable	Value	Provenance	Actions
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	soil_waterPotential_measurement_kilopascal	-72	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	soil_waterPotential_measurement_kilopascal	-102	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	soil_waterPotential_measurement_kilopascal	-109	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	soil_waterPotential_measurement_kilopascal	-79	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	atmospheric_rainfallCumulation_computation_millimetre	0	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	powerSupply_voltage_measurement_volt	5.58	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:52:57.000Z	supply_voltage_measurement_volt	3.838	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:46:12.000Z	soil_waterPotential_measurement_kilopascal	-28	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:46:12.000Z	soil_waterPotential_measurement_kilopascal	-32	Agriscope	
MA4 (agricultural plot)	2025-09-15T08:46:12.000Z	soil_waterPotential measurement kilopascal	-25	Agriscope	



- Scientific Organization
- Scientific Information
- Data
 - Tabular Data
 - Data files
 - Provenances
 - Events
 - Documents
 - Spatial
 - Vocabulary
 - Administration
 - About
 - Tools
 - Open science
 - Web API

- Data View and
- + CSV Imp
- Variable(s)
- Experi
- Scientific
- Germplas
- Germplas
- Devices
- Operator
- Facilities

URI or URL

autogenerated URI

Name *

Enter a name

Description

Describe provenance

Activity

Type *

select a type of activity

Start Date

MM/DD/YYYY hh:mm

End Date

MM/DD/YYYY hh:mm

Url

Provenance agents

Add an agent

Agent type

select a type of agent

Sensor : Camera X (URI)
 Script/software : software X (URI)
 Operator: Jean Dupont (URI)
 Acquisition details: flight height

URI Q

20 entries

	Value	Provenance	Actions
opascal	-72	Agriscope	
opascal	-102	Agriscope	
opascal	-109	Agriscope	
opascal	-79	Agriscope	
putation_millimetre	0	Agriscope	
volt	5.58	Agriscope	
	3.838	Agriscope	
opascal	-28	Agriscope	
opascal	-32	Agriscope	
opascal	-25	Agriscope	



PHIS-OpenSILEX: Measurements & Observations



PHIS Data files View entries

Showing 0 to 20 of 126 entries

Target	Date	Type	Provenance	Actions
SP04001 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04017 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04017 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04005 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04001 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04001 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04002 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04014 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04028 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04028 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04004 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04027 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04014 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04006 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04006 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04018 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04013 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04025 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	
SP04013 (image)	2018-07-30T20:07:00.000Z	RGB image	FullEyeMasked_SweepPhoto	
SP04018 (image)	2018-07-30T20:03:00.000Z	RGB image	FullEyeCentroid_SweepPhoto	



PHIS-OpenSILEX: Measurements & Observations



PHIS Data Files View status

Showing 9 to 20 of 100 entries

Target
SP00400 (json)
SP00401 (json)
SP00402 (json)
SP00403 (json)
SP00404 (json)
SP00405 (json)
SP00406 (json)
SP00407 (json)
SP00408 (json)
SP00409 (json)
SP00410 (json)
SP00411 (json)
SP00412 (json)
SP00413 (json)
SP00414 (json)
SP00415 (json)
SP00416 (json)
SP00417 (json)
SP00418 (json)
SP00419 (json)
SP00420 (json)

Datafile

```
{
  "uri": "phis-egi-demo:id/file/1532980980.8ee60379768a8e5e610ad6795ec69cad",
  "rdf_type": "vocabulary:RGBImage",
  "date": "2018-07-30T20:03:00.000Z",
  "timezone": null,
  "target": "phis-egi-demo:id/scientific-object/so-sp004001",
  "provenance": {
    "uri": "phis-egi-demo:id/provenance/fisheyemasked_sweetpotato",
    "prov_used": [
      {
        "uri": "phis-egi-demo:id/file/1532980980.ebe5ebf57f70afc27689e23dc0abcc17",
        "rdf_type": null
      }
    ]
  }
}
```





PHIS-OpenSILEX: Measurements & Observations



The screenshot shows the PHIS web interface. On the left, a sidebar lists various data categories, with 'Data Files' selected. The main area displays a list of data files, with the first one selected. On the right, a modal window shows the JSON representation of the selected file. Two red boxes highlight the following JSON entries:

```
"uri": "phis-egi-demo:id/device/plantscreen_data_analyser",  
"rdf_type": "vocabulary:Software",  
"settings": null
```

```
"uri": "http://phis.mm.helsinki.fi/id/device/compact_topview_rgb2",  
"rdf_type": "vocabulary:SensingDevice",  
"settings": null
```



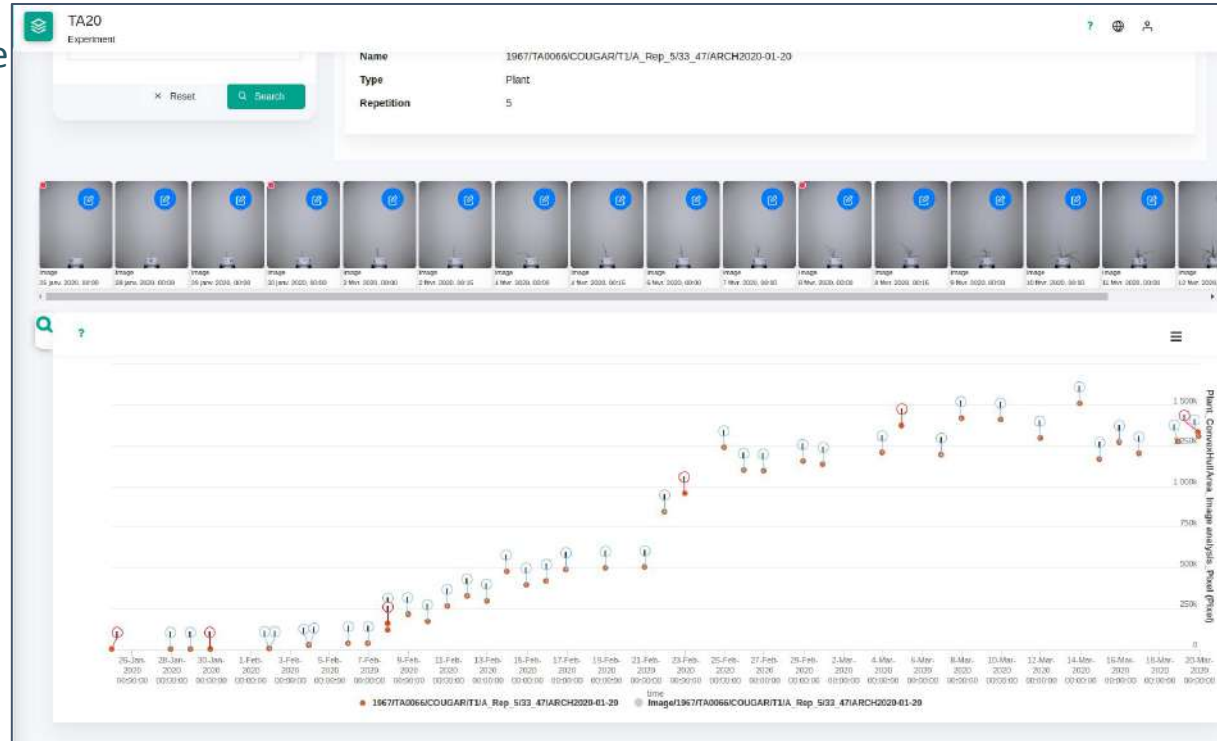


PHIS-OpenSILEX: Measurements & Observations



PHIS Interfaces allow to manage

- **Data**
 - Data visualization
 - Data provenance



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PHIS-OpenSILEX: API & Client connection



Another interface with the data

- **Swagger**

<https://phis.emphasis.fedcloud.eu/egi-demo/api-docs/>

- Based on OpenAPI
<https://www.openapis.org>
- Open description format for API services
- Explore the different web services, and there return
- Describe arguments and gives examples
- Performs requests

swagger

OpenSilex API [Access to swagger.json](#)

BRAPI	Show/Hide	List Operations	Expand Operations
Annotations	Show/Hide	List Operations	Expand Operations
Area	Show/Hide	List Operations	Expand Operations
Data	Show/Hide	List Operations	Expand Operations
Devices	Show/Hide	List Operations	Expand Operations
Documents	Show/Hide	List Operations	Expand Operations
Events	Show/Hide	List Operations	Expand Operations
Experiments	Show/Hide	List Operations	Expand Operations
GET /core/experiments			Search experiments
POST /core/experiments			Add an experiment
PUT /core/experiments			Update an experiment
DELETE /core/experiments/{uri}			Delete an experiment
GET /core/experiments/{uri}			Get an experiment
GET /core/experiments/{uri}/available_facilities			Get facilities available for an experiment





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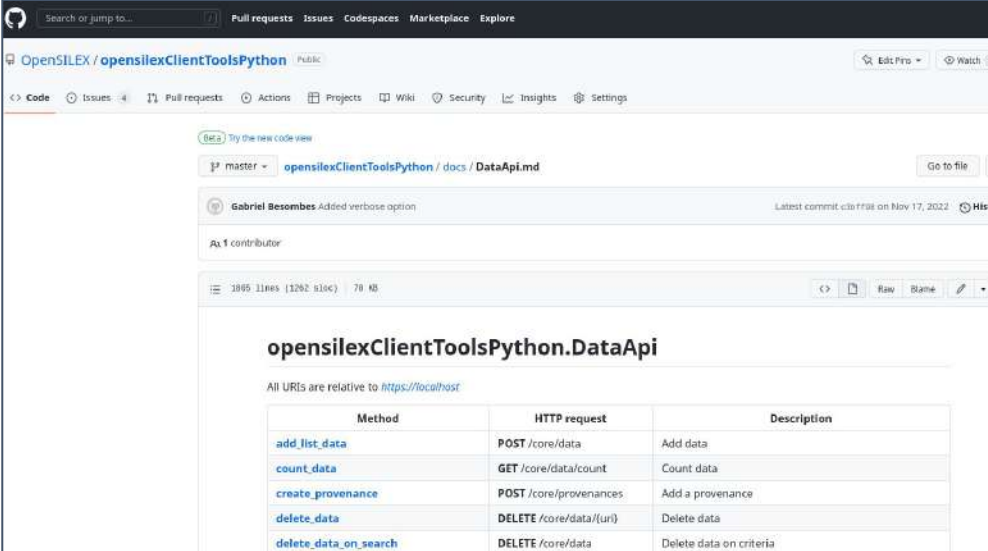


PHIS-OpenSILEX: API & Client connection



Another interface with the data

- Python Client (Scripts) 
 - Repository Github : <https://github.com/OpenSILEX/opensilexClientPython>
 - Based on autogenerated client : <https://github.com/OpenSILEX/opensilexClientToolsPython>
 - Scripts documentation: <https://opensilex-scripts.pages.mia.inra.fr/opensilex-generic-scripts/>
- R Client (Package) 
 - Repository Github : <https://github.com/OpenSILEX/opensilexClientR>
 - Based on autogenerated client : <https://github.com/OpenSILEX/opensilexClientToolsR>



OpenSILEX / **opensilexClientToolsPython** PUBLIC

Code Issues Pull requests Actions Projects Wiki Security Insights Settings

Try the new code view

master opensilexClientToolsPython / docs / DataApi.md

Gabriel Besombes Added verbose option Latest commit c10f788 on Nov 17, 2022

As 1 contributor

2895 lines (1262 sloc) 70 KB

opensilexClientToolsPython.DataApi

All URIs are relative to `https://localhost`

Method	HTTP request	Description
add_list_data	POST /core/data	Add data
count_data	GET /core/data/count	Count data
create_provenance	POST /core/provenances	Add a provenance
delete_data	DELETE /core/data/{uri}	Delete data
delete_data_on_search	DELETE /core/data	Delete data on criteria





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PHIS-OpenSILEX: API & Client connection



Another interface with the data

- Python Client (Scripts) 
 - Repository Github : <https://github.com/OpenSILEX/opensilexClientPython>
 - Based on autogenerated client : <https://github.com/OpenSILEX/opensilexClientToolsPython>
 - Scripts documentation: <https://opensilex-scripts.pages.mia.inra.fr/opensilex-generic-scripts/>
- R Client (Package) 
 - Repository Github : <https://github.com/OpenSILEX/opensilexClientR>
 - Based on autogenerated client : <https://github.com/OpenSILEX/opensilexClientToolsR>

add_list_data

ObjectUriResponse add_list_data(authorization, body=body, accept_language=accept_language)

Add data

Example

```

from __future__ import print_function
import time
import opensilexClientToolsPython
from opensilexClientToolsPython.rest import ApiException
from pprint import pprint

# create an instance of the API class
pythonClient = opensilexClientToolsPython.ApiClient()
pythonClient.connect_to_opensilex_ws(identifier="guest@opensilex.org", password="guest", host="https://localhost")
api_instance = opensilexClientToolsPython.DataApi(pythonClient)
body = [opensilexClientToolsPython.DataCreationDTO()] # list[DataCreationDTO] | Data description [optional]

try:
    # Add data
    api_response = api_instance.add_list_data(body=body, )
    pprint(api_response)
except ApiException as e:
    print("Exception when calling DataApi->add_list_data: %s\n" % e)

```

Parameters

Name	Type	Description	Notes
body	list[DataCreationDTO]	Data description	[optional]



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PHIS-OpenSILEX: Integration for end-user meta analysis

SilexExplorer: A GraphQL service combined with Python/R packages for research purposes

Make your PHIS data integrated and ready for research analysis

- ❖ GraphQL Service : a unique endpoint to access to your entire data
 - To abstract away the differences between databases (RDF / JSON)
 - Independent of REST services

- ❖ R & Python packages (SilexExplorerR, SilexExplorerPy)
 - Filter, extract, structure, table generation.
 - User oriented :
 - Tables ready for analysis
 - You can make your own GraphQL queries



SilexExplorerPy

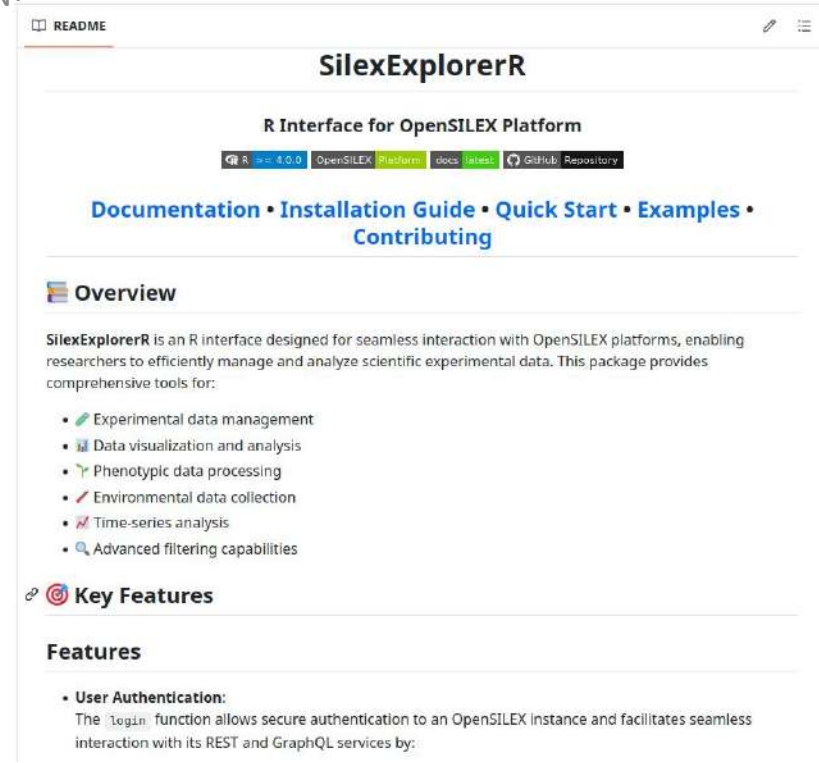
Brief Description: A Python package designed to help researchers extract, visualize, and analyze complex phenotypic and environmental data for in-depth scientific insights.

Table of Contents

- [Description](#)
- [Features](#)
- [Installation](#)
- [Quick Start](#)
- [Project Structure](#)
- [Contributing](#)

Description

SilexExplorerPy is a Python package designed to help researchers extract, visualize, and analyze complex phenotypic and environmental data associated with scientific experiments. It provides a comprehensive set of tools for interacting with OpenSILEX instances to retrieve experimental data, manage scientific objects, and collect environmental information. Ideal for researchers in fields such as agriculture and environment, this package enables efficient data management and filtering by experiments, species, projects, and environmental conditions. It also supports exporting, visualizing, and analyzing the results, facilitating in-depth scientific insights and data-driven decision-making.



SilexExplorerR

R Interface for OpenSILEX Platform

R v. 4.0.0 | OpenSILEX Platform | docs | sales | GitHub | Repository

[Documentation](#) • [Installation Guide](#) • [Quick Start](#) • [Examples](#) • [Contributing](#)

Overview

SilexExplorerR is an R interface designed for seamless interaction with OpenSILEX platforms, enabling researchers to efficiently manage and analyze scientific experimental data. This package provides comprehensive tools for:

- Experimental data management
- Data visualization and analysis
- Phenotypic data processing
- Environmental data collection
- Time-series analysis
- Advanced filtering capabilities

Key Features

Features

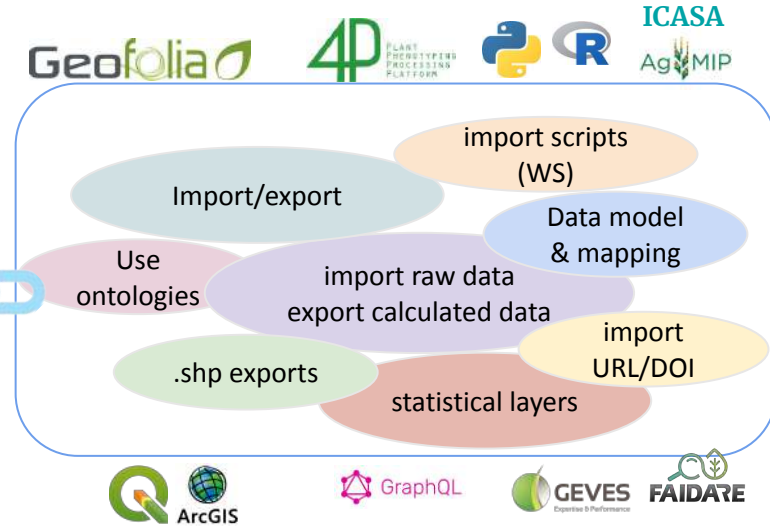
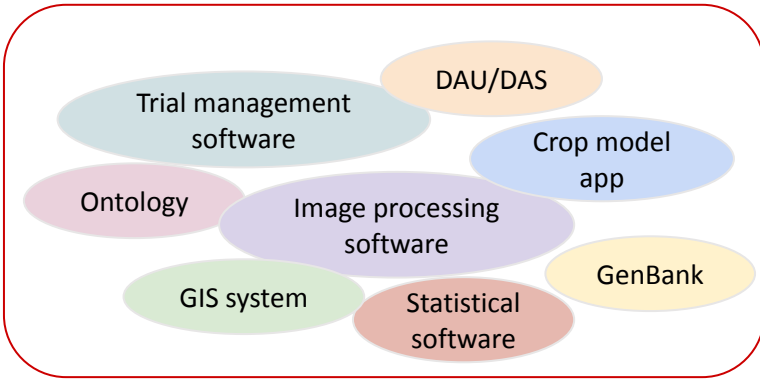
- **User Authentication:**
The `login` function allows secure authentication to an OpenSILEX instance and facilitates seamless interaction with its REST and GraphQL services by:



Conclusion



Ontology driven Information System for Plant Phenomics



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Conclusion



- PHIS/OpenSILEX
 - Used in several phenotyping platforms and serves several communities
 - Work in conjunction with standards (BrAPI - MIAPPE)
 - Modular, scalable and user-adaptive S.I. software
 - Open source software: any new community can help improve it
 - New communities are welcome



PHIS-OpenSILEX useful links

❖ Contact: farzaneh.kazemipour@inrae.fr / isabelle.alic@inrae.fr

❖ OpenSILEX

- ❖ OpenSILEX website: <http://opensilex.org/>
- ❖ OpenSILEX demo: <http://opensilex.org/sandbox/app/> (guest@opensilex.org / *guest*)
- ❖ User documentation: <http://opensilex.org/doc/UserDocumentationOpenSilex.pdf>
- ❖ Scripts documentation: <https://opensilex-scripts.pages.mia.inra.fr/opensilex-generic-scripts/>
- ❖ How to contribute to OpenSILEX?
 - Github repository: <https://github.com/OpenSILEX/>
 - Developer documentation: <https://opensilex.github.io/docs-community-dev/>
 - OpenSILEX Docker: <https://github.com/OpenSILEX/opensilex-docker-compose>

PHIS

- ❖ Research paper: <https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.15385>
- ❖ Variables declaration tutorial: https://www.youtube.com/watch?v=Pvz9o-b_Mok
- ❖ PHIS Demo instance: <https://phis.emphasis.fedcloud.eu/egi-demo/app/>

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