
EPPO PRESENTATION

Improving traceability, transparency, and precision with digital technology

DATE

June 2022

AUTHOR(S)

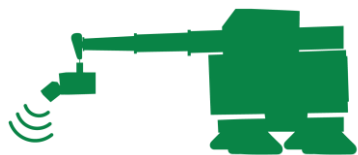
Alexis Comar, Lee West, Nicolas Cheviet



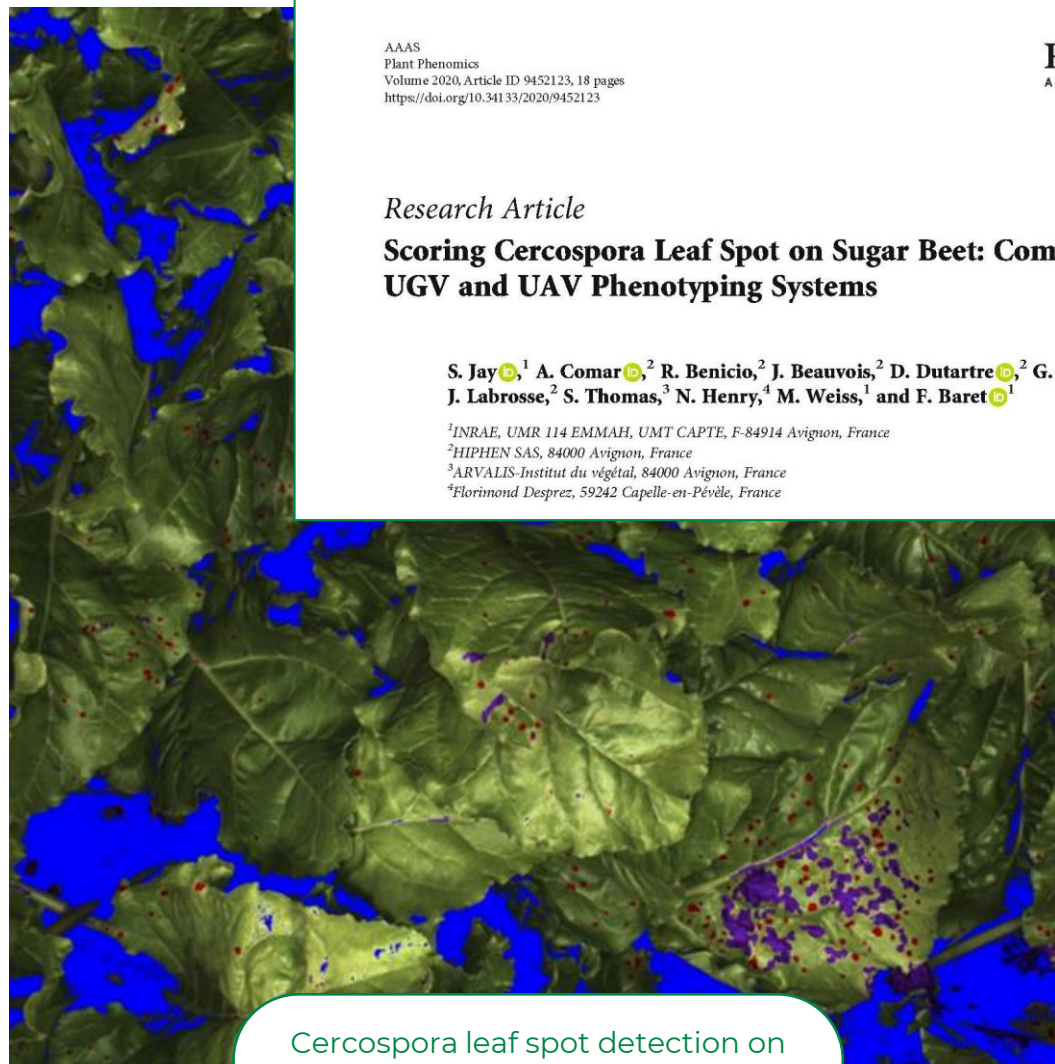
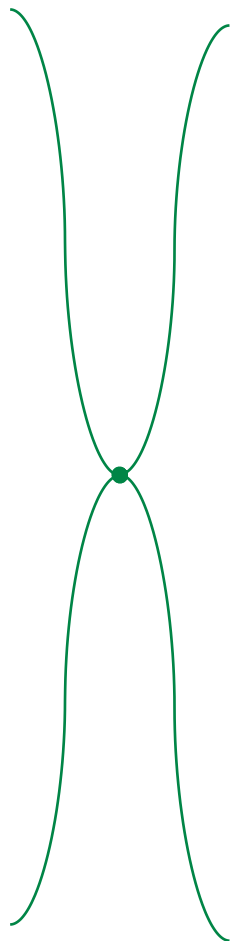
Image analytics in the field to standardize complex traits



Drone



PhenoMobile®



AAAS
Plant Phenomics
Volume 2020, Article ID 9452123, 18 pages
<https://doi.org/10.34133/2020/9452123>

Plant Phenomics
A SCIENCE PARTNER JOURNAL

Research Article

Scoring Cercospora Leaf Spot on Sugar Beet: Comparison of UGV and UAV Phenotyping Systems

S. Jay¹, A. Comar², R. Benicio², J. Beauvois², D. Dutartre², G. Daubige¹, W. Li², J. Labrosse², S. Thomas³, N. Henry⁴, M. Weiss¹ and F. Baret¹

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Cercospora leaf spot detection on sugar beet with **PhenoMobile®**

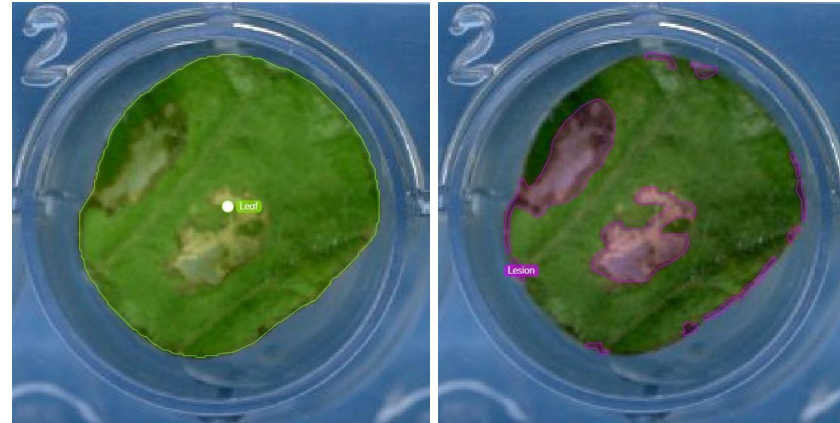
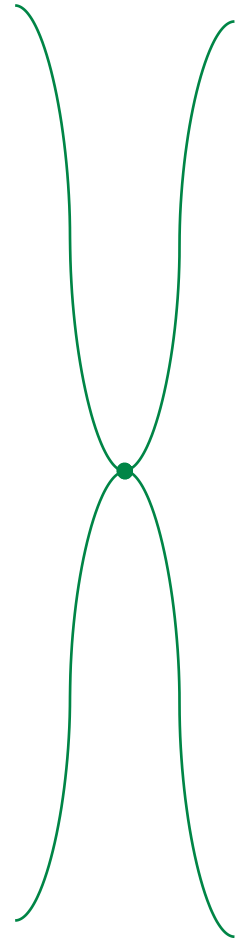
Image analytics in the lab to validate necrosis assessment



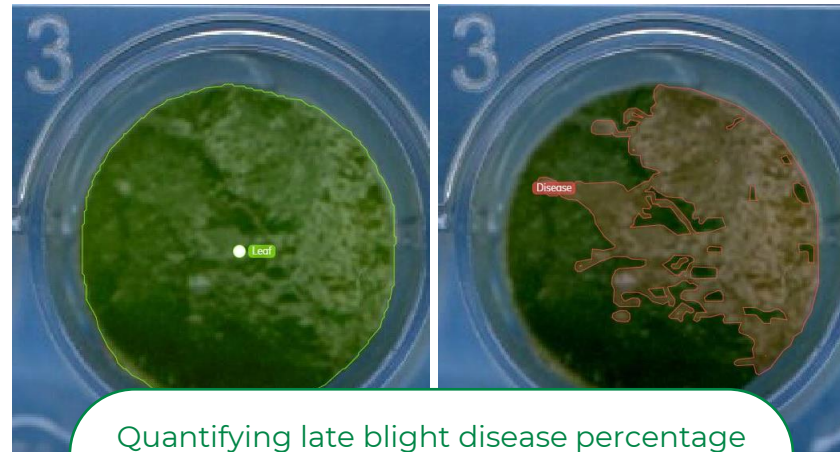
Lab



PhenoStation®



24%
toxicity

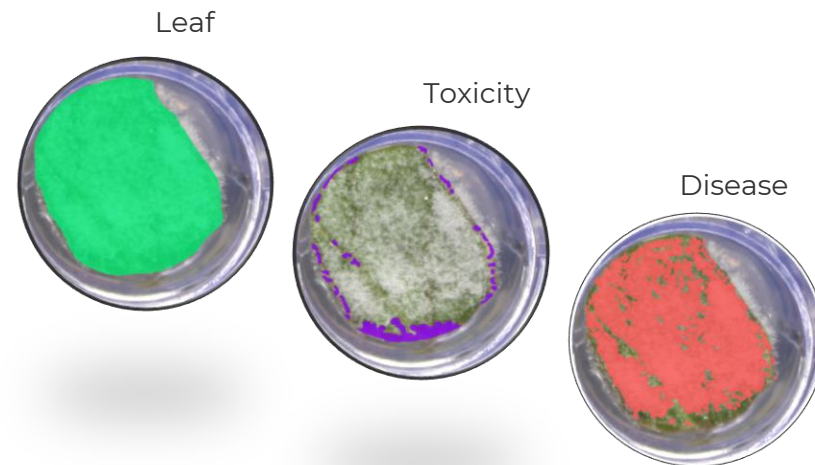
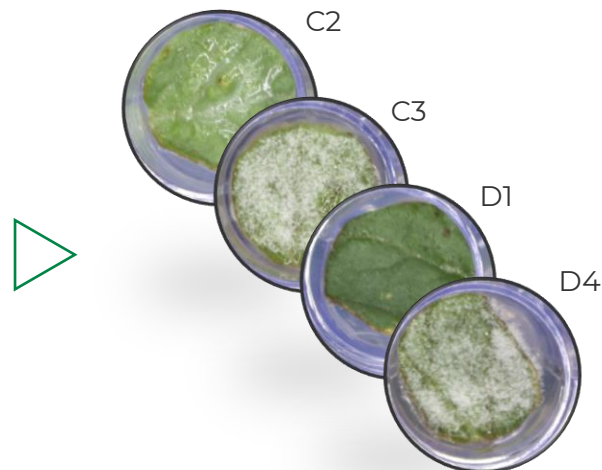


67%
disease

Quantifying late blight disease percentage
& toxicity with **PhenoStation®**

From raw images to plant disease assessment

Plates XYZ



You **upload your raw images**, acquired with a strict acquisition protocol and set-up, to **Cloverfield**.



Hiphen **detects the well plate** in the image and **extracts each well** individually.



Hiphen detects the **entire leaf area**, **toxicity** and **disease** for each leaf disk by deep learning algorithms.

	A	B	C	D	E
1	image_name	well_name	well_position	percent_disease	percent_toxicity
2			A1	9	11
3			B1	13	11
4			C1	12	15
5			D1	8	27
6			A2	27	42



Hiphen restitutes the results through **Cloverfield**, less than **1 week after data upload**.

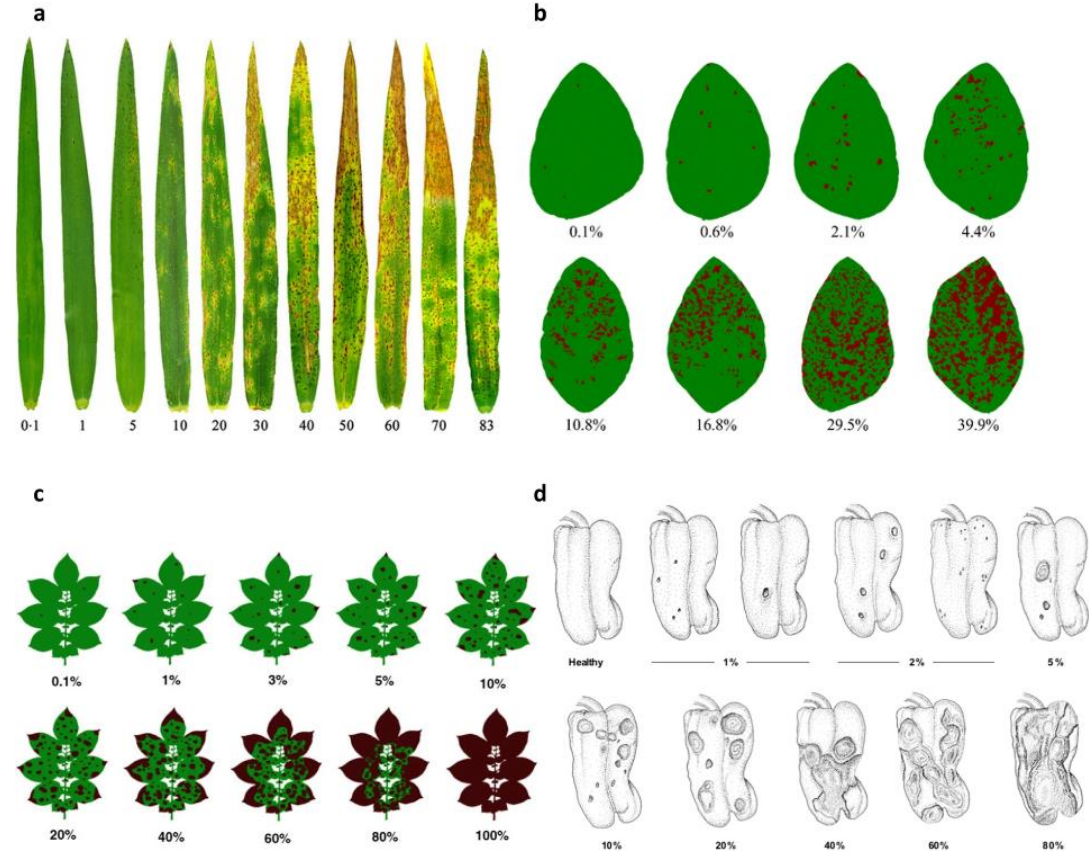
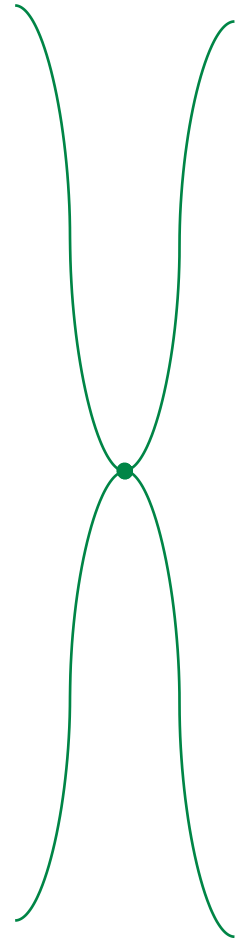
Image analytics are possible for all disease evaluation following EPPO guidelines



Which sensing system?

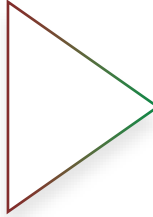


Which processing method?





EPPO guidelines help align and facilitate agreement between researchers and regulatory reviewers



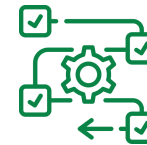
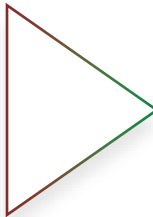
EPPO guidelines standardize processes



Assessment quantity limited by time



Data collected by human eye



Improve Traceability



Improve Transparency



Improve Precision

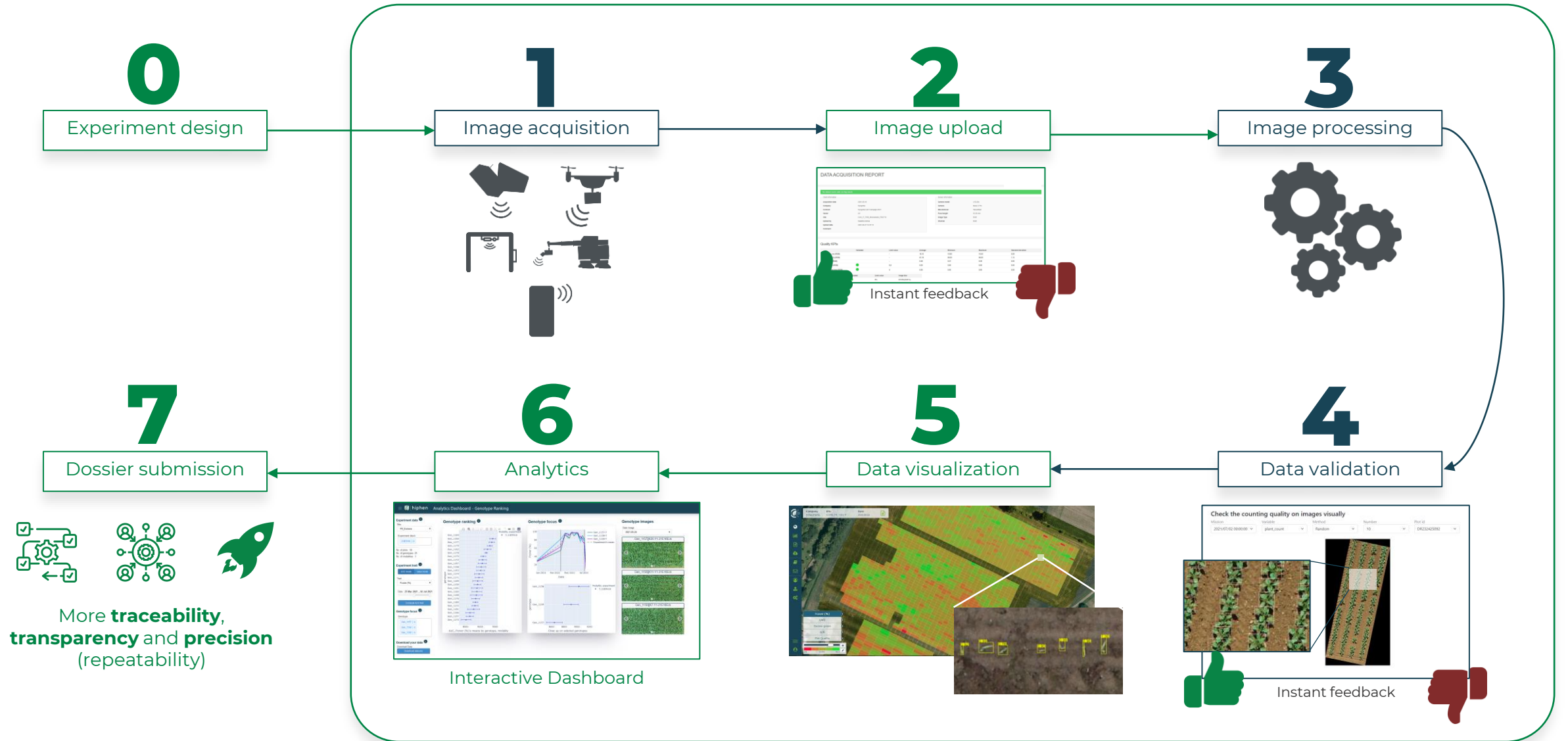


Analog

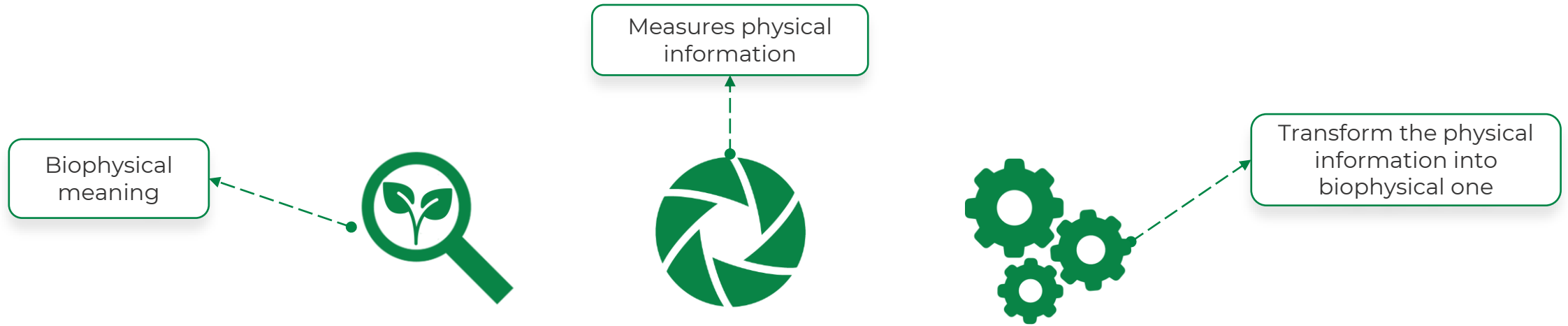


Digital

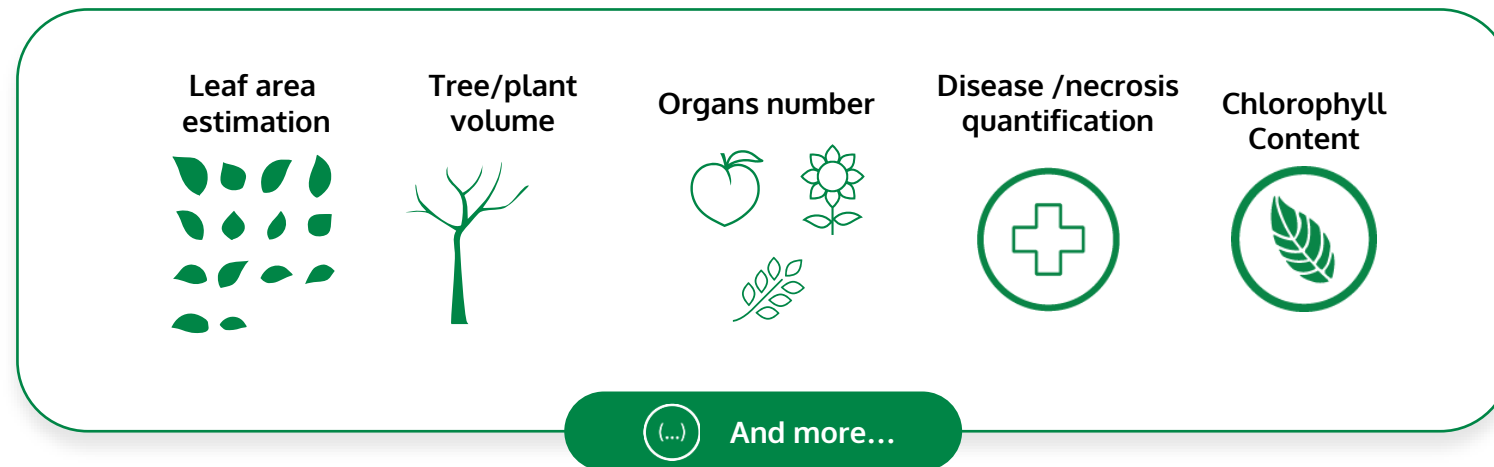
The global workflow of digital acquisition



The phenotyping equation for success



$$\text{Traits} = \text{Sensors} \times \text{Methods}$$



A wide range of devices and sensors to collect plant data



Traits = Sensors x Methods



Lighting equipment



Spectrometer



LIDAR



Multispectral cameras



RGB cameras



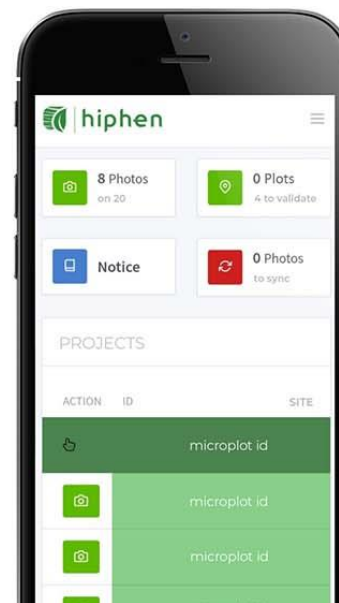
Micrometers



And more...



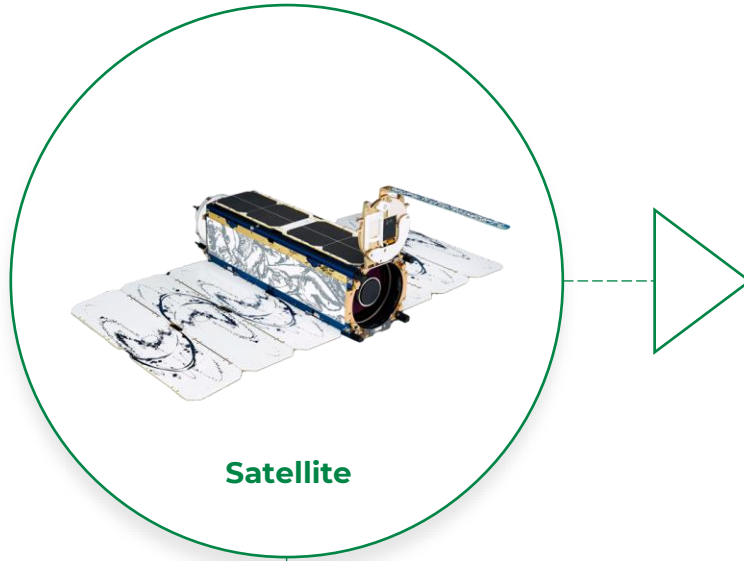
Thermal cameras



Nitrogen fertilizer efficiency from satellites

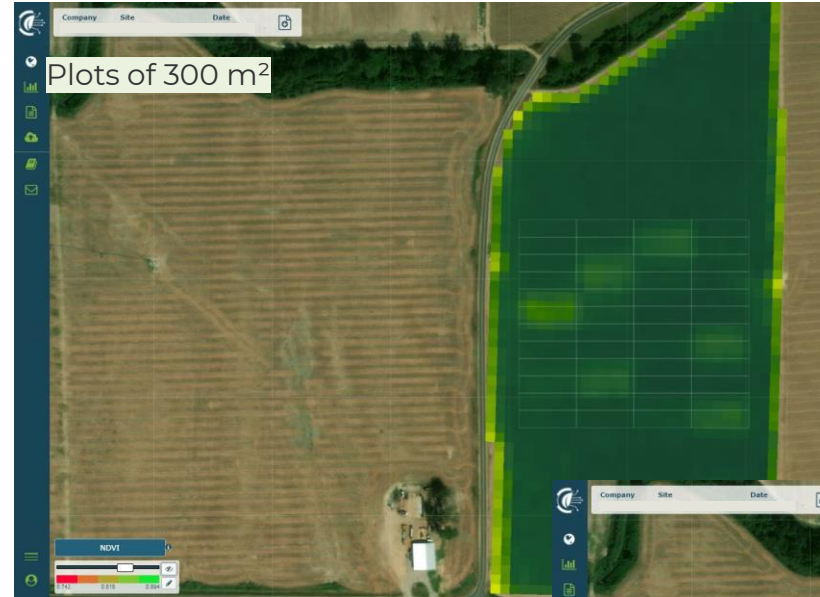


Traits = Sensors x Methods



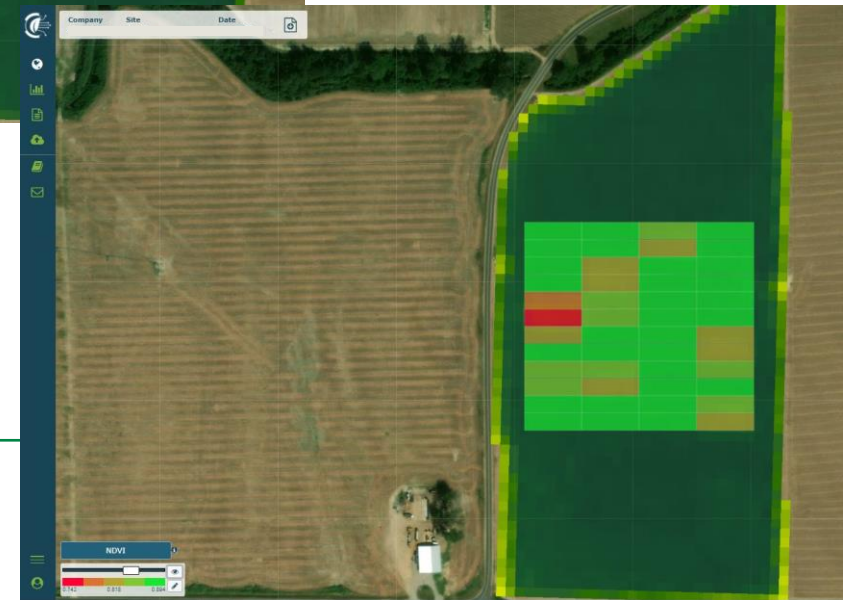
Satellite

Vegetation Indices Field heterogeneity And more...



Have a global view of your trial

Quantify the differences between modalities








Traits = Sensors x Methods



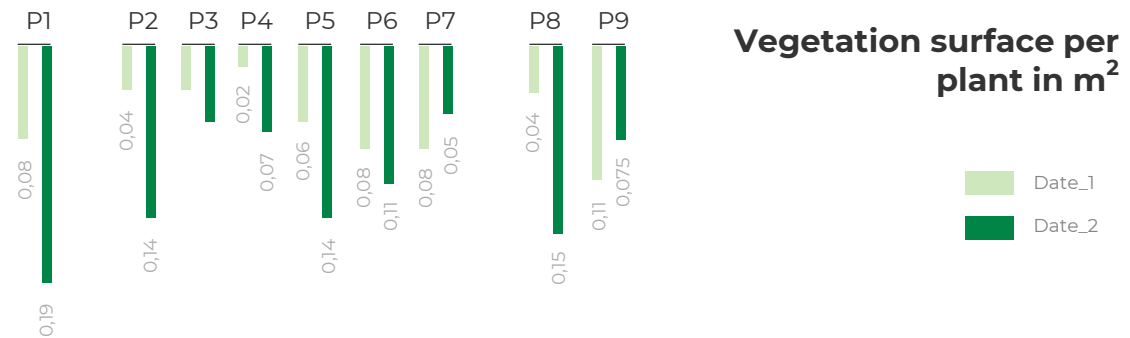
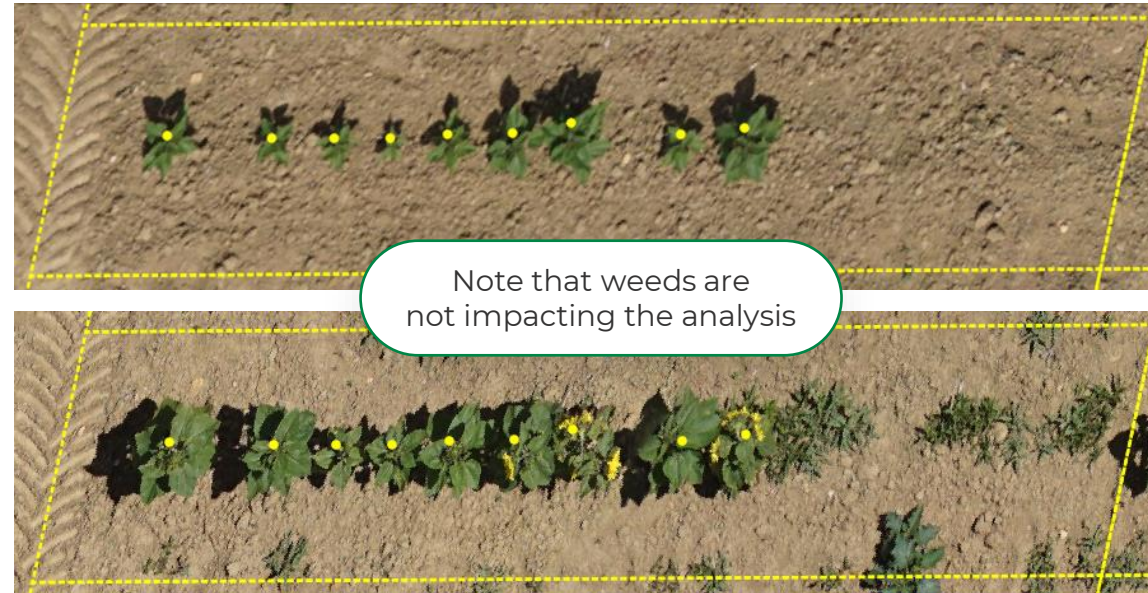
Drone

- 
 Green fraction
- 
 Vegetation surface
- 
 And more...

Date_1



Date_2



Plant by plant analysis can be done through times to study complex dynamics and interactions




Flowering intensity from proximal sensors

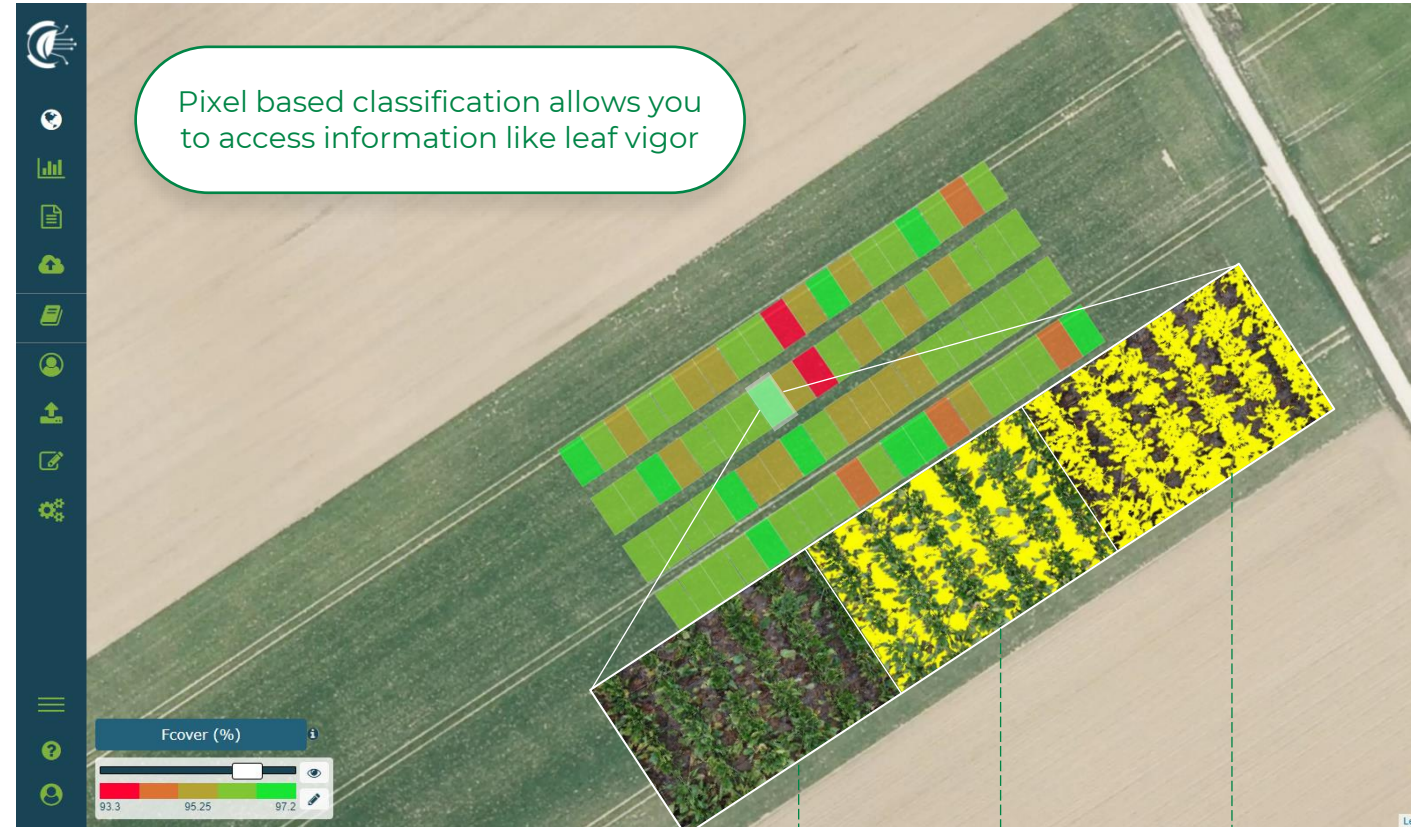


Traits = Sensors x Methods



Hand-held device

- 
 Green fraction
- 
 Early vigor
- 
 And more...



Pixel based classification allows you to access information like leaf vigor



Raw image of the plot

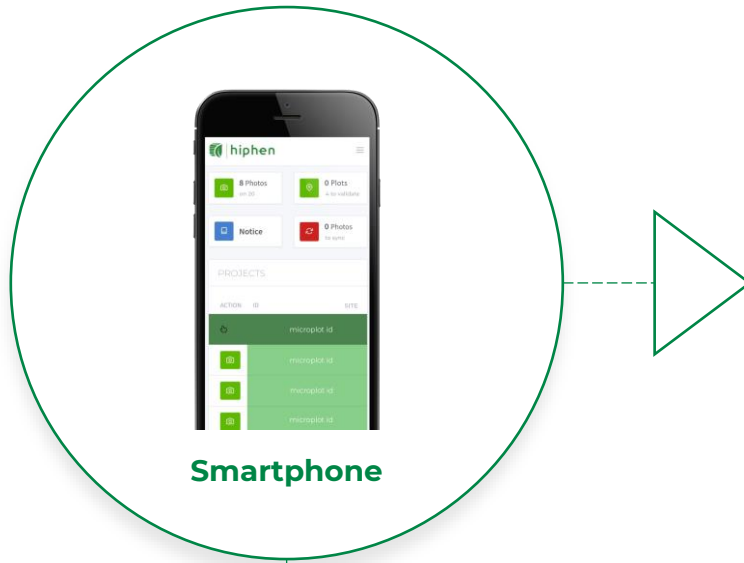
Segmentation of the soil (yellow mask)

Vegetation cover (yellow mask)

Aphid quantification from smartphone



Traits = Sensors x Methods



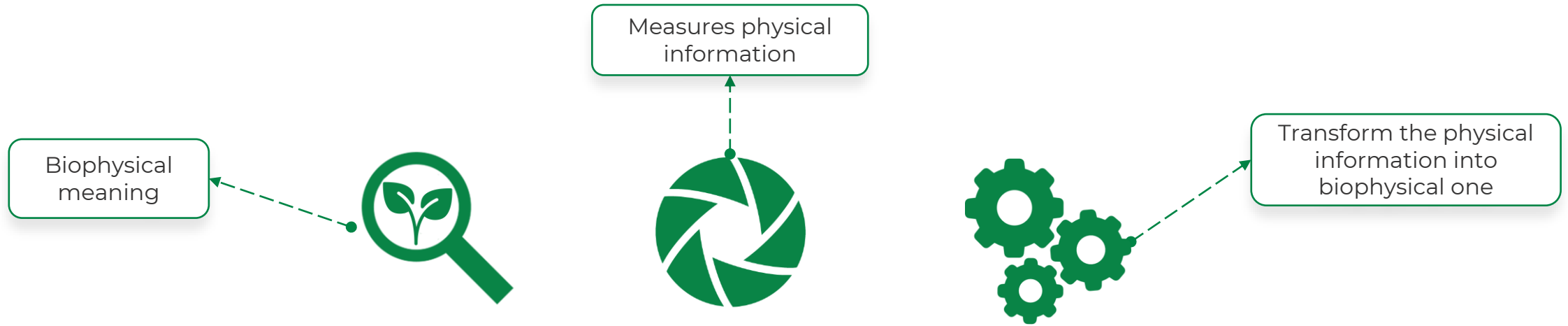
Smartphone

-  Disease detection
-  Plot quality
-  And more...

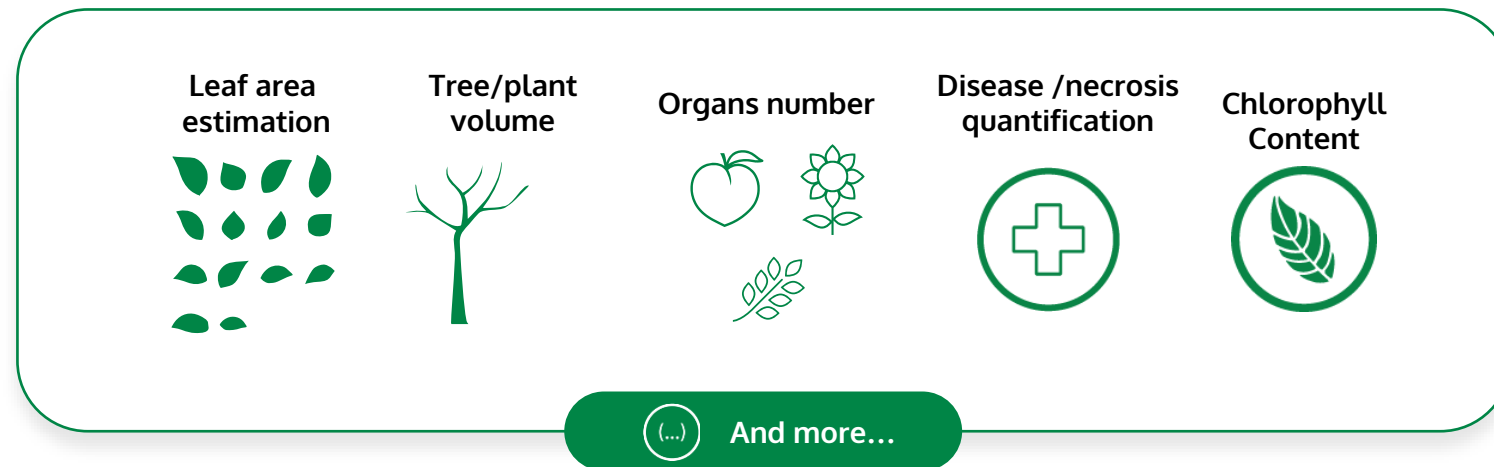


Detecting aphid count on leaves to estimate the performance of your product at the plant and organ level




The phenotyping equation for success



$$\text{Traits} = \text{Sensors} \times \text{Methods}$$



Several methods exists depending on the trait you wish to obtain:

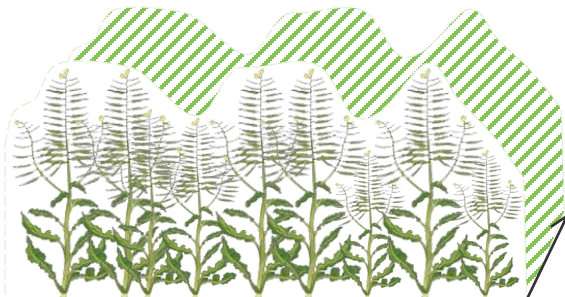
Traits = Sensors x Methods



With guidelines

Geometric interpretation

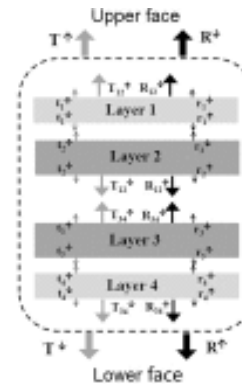
- VI's
- Biovolume
- And more...



With guidelines

Mechanistical models

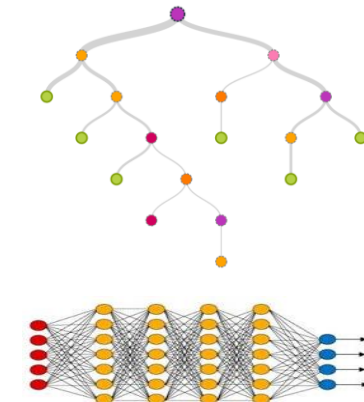
- **PROSPECT / PROSAIL**
(simulate electromagnetic signal of vegetation)
- **And others...**



With guidelines

Machine Learning

- Decision trees
- Deep Learning
- Machine Learning



It is crucial to validate the method on the dataset

Training dataset



Applies only for Machine Learning

Public



Image courtesy of: The Global Wheat Head Dataset



Private

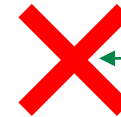
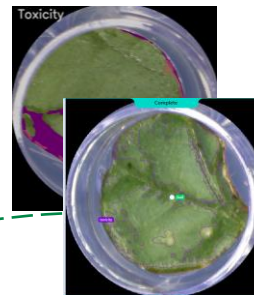


enrich

Validation dataset



Applies to all data processing methods



Subsample

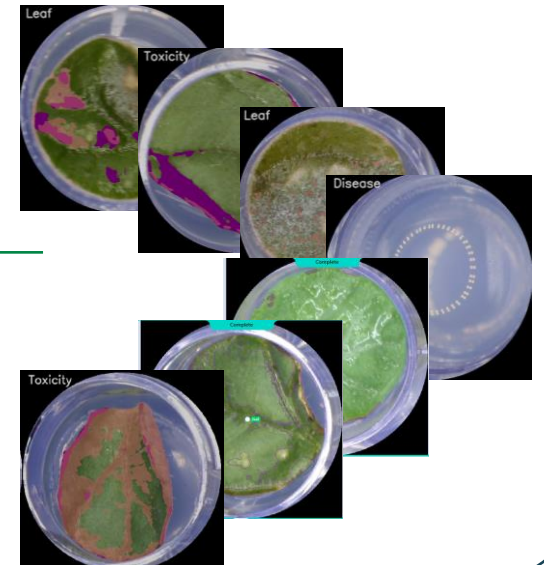


Through a web interface

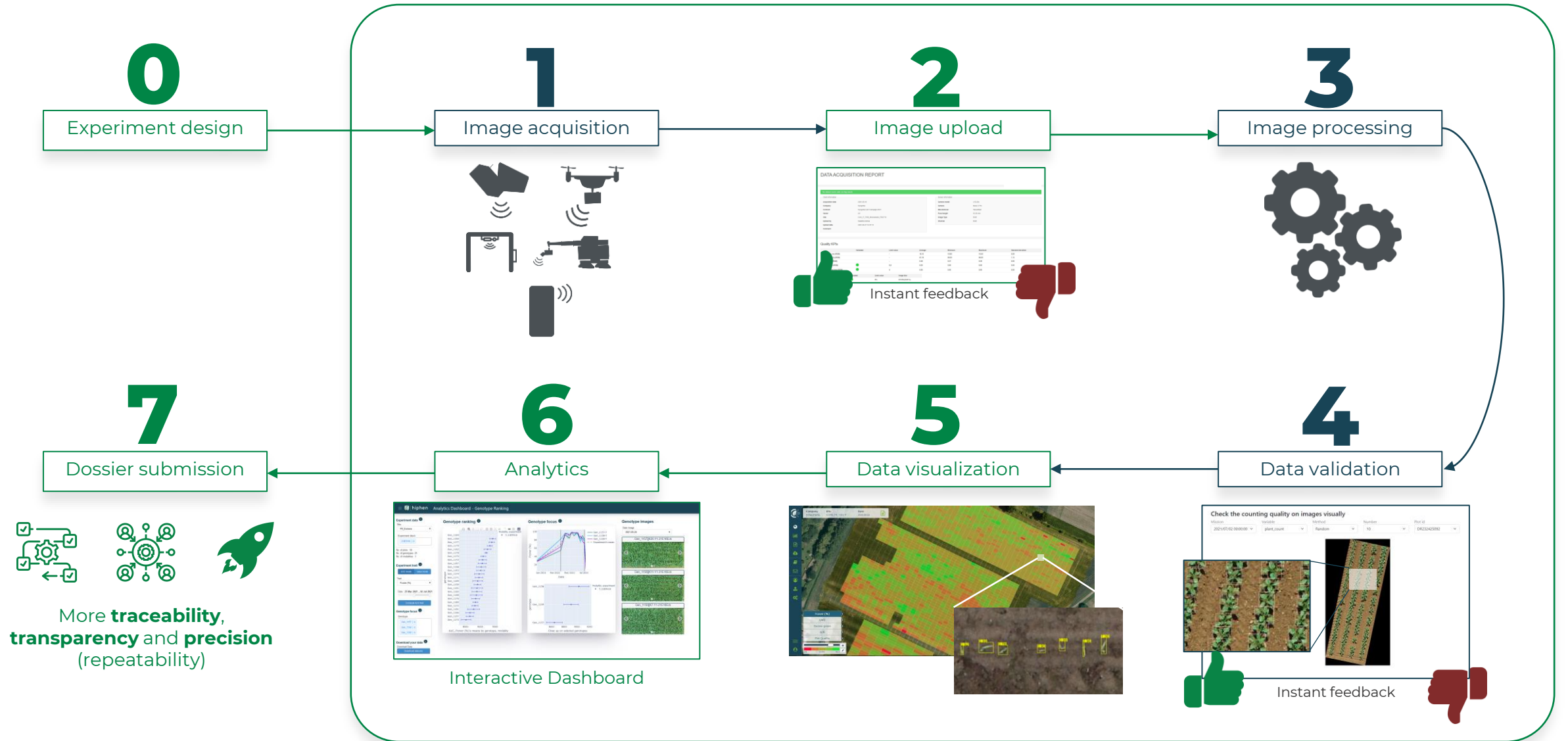
Experience/dossier dataset

	A	B	C	D	E
1			well_position	percent_disease	percent_toxicity
2	A1	A1		9	11
3	B1	B1		13	11
4	C1	C1		12	15
5	D1	D1		8	27
6	A2	A2		27	42

Applies to all data processing methods



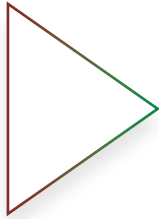
The global workflow of digital acquisition



The status of imaging data



EPPO guidelines help align and facilitate agreement between researchers and regulatory reviewers



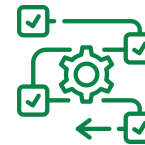
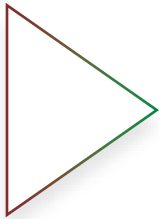
EPPO guidelines standardize processes



Assessment quantity limited by time



Data collected by human eye



Improve Traceability



Improve Transparency



Improve Precision



Analog



Digital

Now



Various storage system
(SGBD, files, NAS ...)

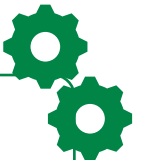
- Data duplication
- Data corruption
 - Low security
- Hard to retrieve data

With digital imaging

- High availability
- Secured / controlled access
- Data durability
- Centralized data

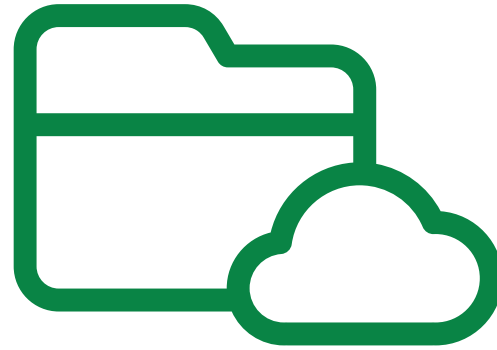


- Data standardization
- Data unique identification
 - Automation

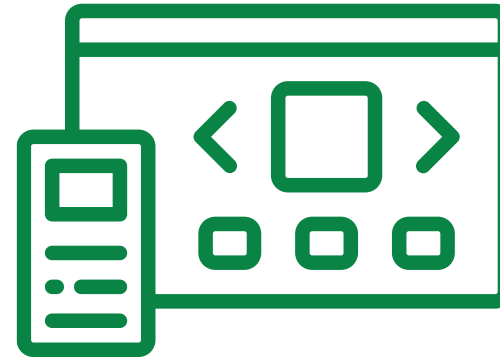




Normalized data inputs



Cloud-based engine



Visualization interface

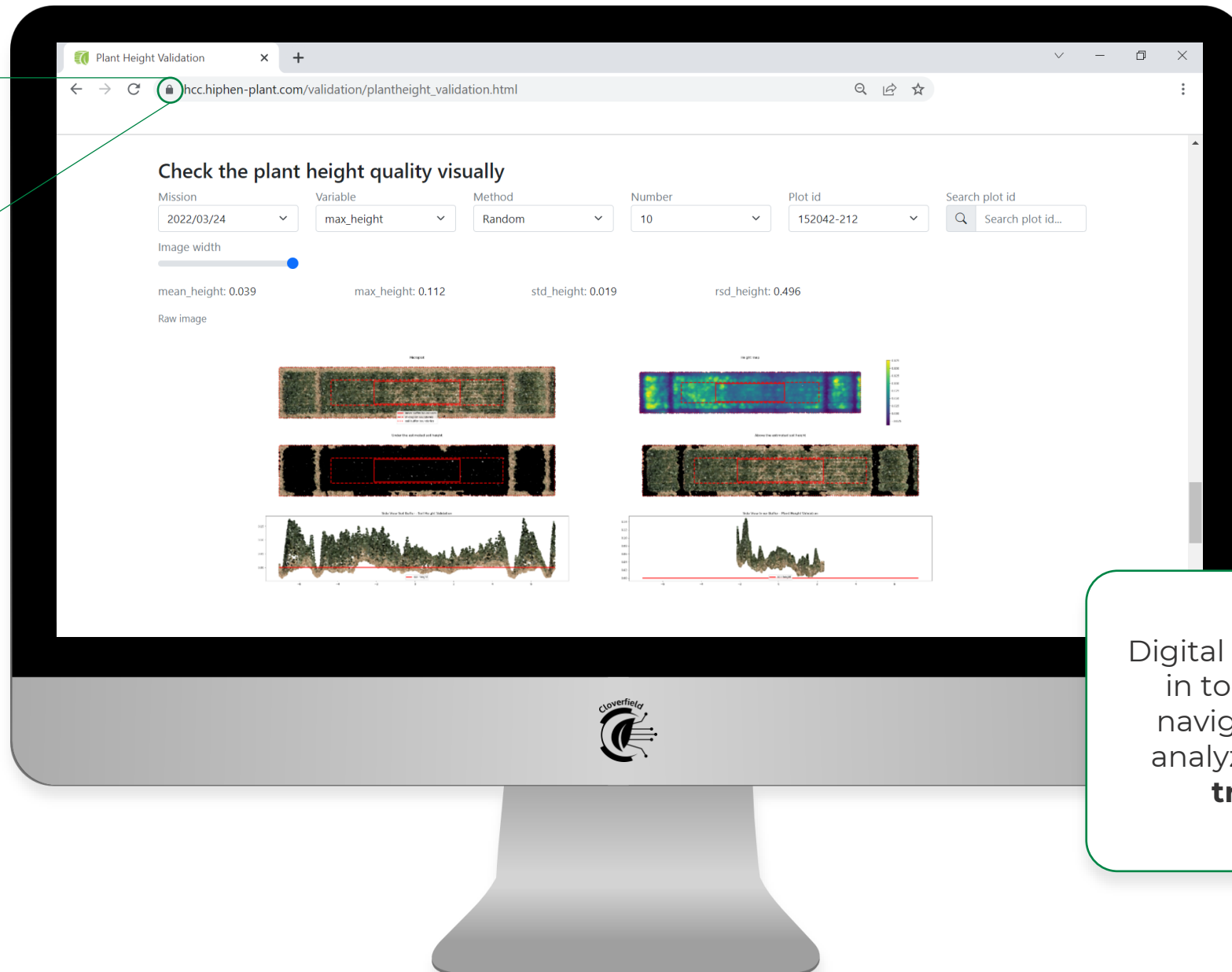


Analytics

Transparency is about making the data and the results accessible to all



Secured interface
with restricted
access



Digital technology brings
in tools that allow to
navigate, inspect and
analyze data, for more
transparency

We provide easily digestible data reports & dashboards



Browse your traits intuitively



Understand your data



Access Quantifiable Records



Cloverfield
Cloverfield integration
in progress...



Hiphen runs projects like these routinely in Cloverfield

Easily drag and drop your datasets



All your sites accessible in one place




The screenshot displays the Hiphen software interface. On the left, a map of Europe shows various field locations marked with colored pins. A central window shows a detailed view of a field layout with rows of crops, color-coded by treatment. To the right, an ANOVA table provides statistical results for the field cover data.

ANOVA Fcover results				
SUMMARY	Count	Sum	Average	Variance
Rep A	12	60.9	5.075	0.268
Rep B	12	56.5	4.708	0.226
Rep C	12	51.0	4.250	0.263
Rep D	12	47.7	3.975	0.222
TRT 1	4	18.1	4.525	0.243
TRT 2	4	17.5	4.375	0.509
TRT 3	4	19.3	4.825	1.043
TRT 4	4	17.9	4.475	0.469
TRT 5	4	16.7	4.175	0.409
TRT 6	4	17.4	4.350	0.137

ANOVA						
Source of Variation	SS	df	MS	F	P-value	Fcrit
Replicates	8.546	3	2.849	18.812	2.71317E-07	2.892
Treatment	5.767	11	0.524	3.463	0.003	2.093
Error	4.997	33	0.151			
Total	19.310	47				

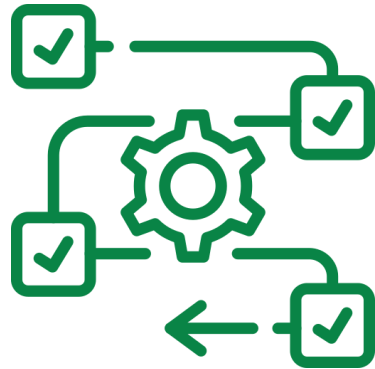
All your traits only a click away

ANOVA analysis to evaluate variance

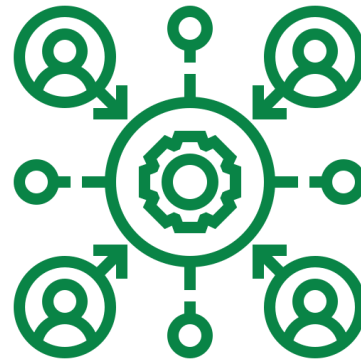
Download your results in one click



Conclusion: using image analytics as a tool to facilitate regulatory dossiers processing



Data Traceability



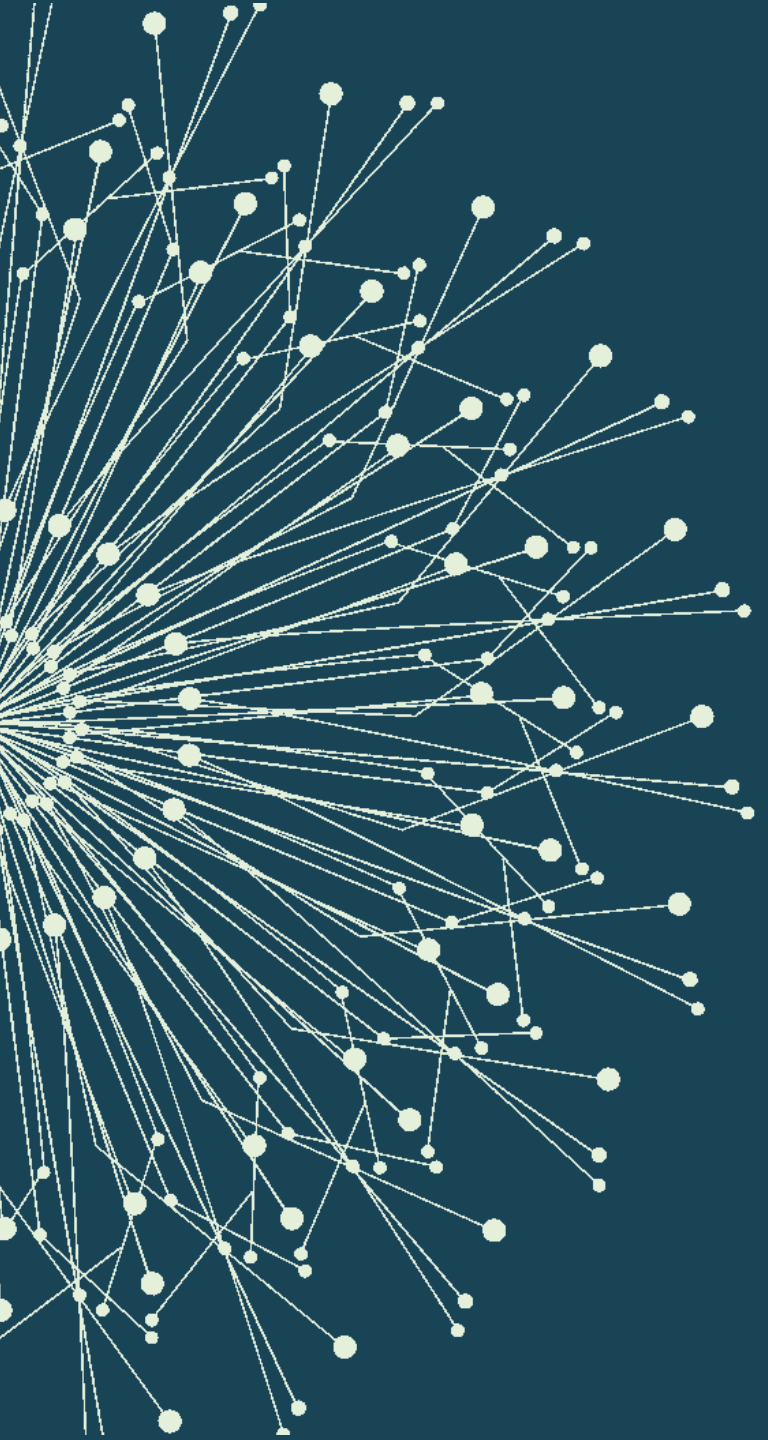
**Data Transparency
& Centralization**



Data Precision

An aerial photograph of a lush green agricultural field, possibly corn. A red tractor is visible in the middle ground, moving through the rows. A person is standing near the tractor. A small white drone is flying in the air above the field. The text "Thank You!" is overlaid in the center in a white, bold font, with a small green leaf icon above the letter 'h' in "Thank".

Thank You!



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