



# BEETPHEN

Sugar Beet Phenotyping in Breeding Trials Using UAV

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# Objective of BEETPHEN

To **evaluate** the use of **UAV's** imaging systems,  
and **compare** them to ground-based systems (imaging  
and non-imaging) and classical field observations (time  
and labour consuming)

... for **crop phenotyping** in sugar beet breeding trial plots



... with the focus on **foliar disease** as specific trait to  
phenotype

# Why sugar beet phenotyping?

- Large breeding assessment of resistant sugar beet to biotic stresses coupled with the identification of targeted traits and their genetic background
- Field phenotyping with high accuracy and reliability required
- Small dimensions of breeding trial plots (around 10m<sup>2</sup>) and need for frequent revisits



# Why UAV imaging systems?



- Remote sensing = high potential for monitoring plant growth and field conditions
- UAVs
  - Constraints linked to small size of breeding trial plots and need for frequent revisits met.
  - Delivery of very high resolution imagery with a flexible temporal resolution at moderate cost
  - Operated regardless of difficult field conditions access (waterlogging or tall crops) and in a non-destructive way.
  - Easier to deploy compared to ground-based vehicles (advantage as breeding trials dispatched over a wide geographic area)
  - Possible “carrier” for different sensors
    - multispectral/high-resolution hyperspectral remote sensing imagery appropriate to produce optical indices related to the health/stress status of crops
  - Remote sensing approaches expected to quantify disease severity
    - accurate, objective and rapid
    - allowing high throughput phenotyping
    - powerful alternative to visual assessments

# Scientific goals



1. Relevant assessment of foliar disease for sugar beet breeding trials using UAV imaging, in combination with ground-based measurements and visual field observations
2. Evaluation of different sensors, platforms and selection of the most suitable ones to breeders need regarding foliar disease detection and quantification
3. Development of a data acquisition and processing methodology for the assessment of the resistance to foliar disease, and validation of the produced algorithm

# Expected results



To deliver a rapid operator-independent tool to assess in a standardized way diseases at the breeding trial plot level.

Potential users:

- breeding companies and institutions
- companies involved in fungicide treatment screening (at field level) or in disease/fungicide application forecast
- agricultural research centres
- crop phenotyping companies
- agricultural UAV companies
- agricultural remote sensing sector
- agricultural sensor and robotics companies

# Description of tasks



Disease symptoms will be assessed during two successive years through several specific artificially inoculated breeding trials.

Inoculated trials will be compared to non-inoculated ones in a replicated plots experimental design. Selected varieties will show a gradient of sensitivity to the disease.

In situ visual observations (disease symptoms quantification) will be performed several times after crop inoculation. In the meantime UAV images (with embedded RGB, multispectral and hyperspectral imaging sensors) and similar ground-based spectral information will be acquired.

# Expertises & contributions



- Sugar beet breeding and seed production
- Sugar beet field trials and phenotyping/genotyping assessment
- Phytopathological specificities related to sugar beet



- Expertise in imaging and non-imaging hand-held/embedded ground-based sensors
- Data management, processing and analysis of NIR spectroscopic data and hyperspectral images treatment



- Hyperspectral ground data collection and UAV image acquisitions
- Preprocessing of UAV images and index calculation
- Supervised and non-supervised classification for crop traits assessment

# Sensors and platforms

## IMAGING

- RGB, RE and Multispec 4C cameras mounted on a Sensefly eBee
- Hyperspectral camera mounted on a AT8 octocopter



## NON-IMAGING

Ground-based measurements for the calibration of the UAV sensors data:

- CRA-W: Chlorophyll meter, fluorimeters, embedded spectrometers
- VITO: ASD hyperspectral radiometer



# Project web page

[www.cra.wallonie.be/en/the-projects/beetphen](http://www.cra.wallonie.be/en/the-projects/beetphen)



## Sugar beet phenotyping in breeding trials using UAV

### Objectives

This project aims at applying the UAVs potential for the quantitative assessment of a specific plant disease within breeding trial plots.

### Description of tasks

Disease symptoms will be assessed during two successive years through several specific artificially inoculated breeding trials. Inoculated trials will be compared to non-inoculated ones in a replicated plots experimental design. Selected varieties will show a gradient of sensitivity to the disease. In situ visual observations (disease symptoms quantification) will be performed several times after crop inoculation. In the meantime UAV images (with embedded RGB, multispectral and hyperspectral imaging sensors) and similar ground-based spectral information will be acquired.

### Expected results

This project is expected to deliver a rapid operator-independent tool to assess in a standardized way diseases at the breeding trial plot level.

The specific expected scientific results are

- Evaluation of different sensors, platforms and selection of the most suitable combination for the disease detection and quantification;
- Development of a data acquisition and processing methodology for the assessment of the resistance to the disease for sugar beet breeding trials using UAV imaging, and validation of the produced algorithm.

The potential users are breeding companies and institutions, companies involved in fungicide treatment screening (at field level) or in disease/fungicide application forecast, agricultural research centres, crop phenotyping companies, agricultural UAV companies, agricultural remote sensing sector, agricultural sensor and robotics companies.

### Contribution

This project is coordinated by SESVanderHave (SV). SV presents important field trial potentialities and has also large experience in the follow up and assessment of in situ sugar beet breeding field trials. SV will provide its sugar beet field trials and its breeder expertise in variety and disease assessment. These expertizes will be useful to lead the study and to collect field observations on the disease as reference data for the study.

The expertise of VITO for UAV (equipment, flights, pre-processing and processing) and hyperspectral plant stress detection will be used to acquire, process and analyse images over the trials.

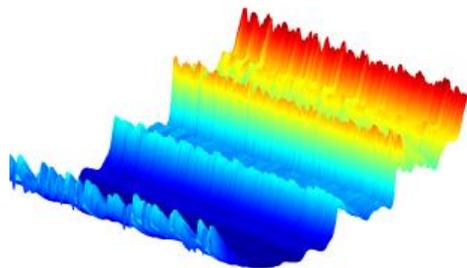
The expertise of CRA-W in ground-based multispectral and near infrared (NIR) hyperspectral applications as well as in chemometrics will provide support in the use of hand-held/embedded field devices to validate the acquired spectral information in relation with the visual observations.



# Vibrational Spectroscopy and Chemometrics

Training Session

12 March–16 March 2018



## Vibrational Spectroscopy

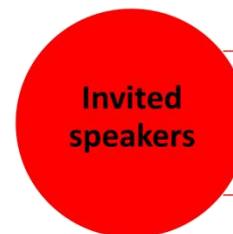
NIR/MIR/RAMAN/NIR microscopy and Imaging

Embedded & on-line NIR/networks/uncertainty

Sampling/Tips and Tricks



## Chemometrics applied to vibrational data



TOM  
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<http://www.cra.wallonie.be/en/events/>

# Thank you for your attention ...

