Belair Hesbania 2015

BELAIR WORKSHOP 2016 - NOVEMBER 8, 2016 - BRUGES, Belgium

Stephanie Delalieux, Bas Van Wesemael, Viviane Planchon
OUTLINE

» Introduction
  » Study site
  » Thematic focus & Aim
  » Team
  » Collaboration nature

» Campaigns:
  » In-situ
  » UAV
  » Airborne
  » Satellite

» Analysis and preliminary results

» Feedback
INTRODUCTION – STUDY SITE
INTRODUCTION – THEMATIC FOCUS & AIM

» “The development of efficient management strategies in capital-intensive fruit crops.”

» “Mapping of properties in cropland soils.”

» “Development of geo-information products for both the Belgian potato processing industry and research centers on potato crop, as an answer to the industry’s specific needs regarding crop condition, growth monitoring and yield estimates and forecasts.”
INTRODUCTION: TEAM

BAS VAN WESEMAEL, Viviane Planchon, Roland Valcke, Jean-Pierre Goffart, Feriel Ben Abdallah, Yannick Curnel, Isabelle Picard, Laurent Jits, Stefan Livers, Johan Mijnendonckx, Bart Bomans, Tom Verstappen, Kristin Vreys, Daniel Iordache, Koen Meuléman, Bart Ooms, KRISTOF VAN OOST, Miet Boonen, Tom Deckers, Yasmin Vanbrabant, Ben Somers and Stephanie Delalieux
INTRODUCTION: COLLABORATION NATURE

Related ongoing projects:
- HyperTemp
- Trustee
- FruitFly
- BELCAM
- iPOT
- POTFLUO project (SPW-DGA)
- VISA project (CRA-W)

Related ongoing thesis projects:
- PhD C. Delloye (BELCAM)
- PhD F. Ben Abdallah « Étude des potentialités des indices basés sur la concentration en composés phénoliques des feuilles pour l'évaluation du statut azoté de la culture de pomme de terre » (POTFLUO)
- PhD Yasmin Vanbrabant (KUL) « Evaluation of novel remote sensing technologies to extract canopy vigor and crop load dynamics in fruit orchards »
- MSc Marie Mestdagh (UCL -ELI promoter P. Defourny - Y. Curnel) “ Estimation du contenu en chlorophylle de la pomme de terre par télédétection hyperspectrale aéroportée », based on BELAIR 2013 data
- MSc Catheline Pieters (KUL) (HyperTemp)
- Postdoc Fabio Castaldi « The evaluation of forthcoming satellites for mapping topsoil organic carbon in croplands »
- Kuniaki Uto (HyperTemp - Grenoble)

Related upcoming projects (submitted):
- H2020 MSCA ITN 2016 - Postdoc (RPAS4AGRI and IDSSA4EU)
- IWT - LA
- EFRO
- Demo project Dept Landbouw en Visserij
Part I: Fruit crop management

BELAIR WORKSHOP 2016 - NOVEMBER 8, 2016 - BRUGES, Belgium

Stephanie Delalieux, Roland Valcke

Thanks to Laurent Tits, Johan Mijnendonckx, Bart Bomans, Stefan Livens, Tom Verstappen, Kristin Vreys, Daniel Iordanache, Koen Meuleman, Bart Ooms, Aleksandra Sima, Dirk Nuyts, Pieter-Jan Baeck, IJs Reusen, Kristof Van Oost, Miet Boonen, Tom Deckers, Yasmin Vanbrabant, Catheline Pieters, Jonathan Van Beek, Ben Somers
HOW : IN-SITU CAMPAIGNS

In-situ:
- Physiological measurements
- Chlorophyll fluorescence
- Hyperspectral measurements
- FLIR
- Sunphotometer
- Yield data collection
- Leaf samples - biochemical parameters
HOW: AIRBORNE AND SPACEBORNE CAMPAIGNS

**Airborne:**
- UAV ebee: RGB, MS, RE
  - Acquisition dates: 21/05, 12/6, 1/7, 13/8, 9/9
- UAV octocopter: Cosicam (internal VITO funding)
  - Acquisition dates: 11/5, 21/5, 12/6
- Manned aircraft - APEX: 1/7
  - Quicklooks available on: [http://www.apex-esa.org/content/quicklooks](http://www.apex-esa.org/content/quicklooks).

**Spaceborne:**
- DMC/Deimos
  - Acquisition dates:
    - 4/6, 11/6, 14/6, 1/7, 11/7, 1/8, 7/8, 21/8, 31/8, 10/9
- RapidEye
  - Acquisition dates: 13/5, 30/6, 17/7, 31/8, 11/9
- Sentinel 2
  - Acquisition dates: 05/08, 22/8, 03/12
WHERE: STUDY AREA

- Strawberries
- Pear - thinning
- Reference
- Pear targets
- Nutrient
STRAWBERRIES
STRAWBERRIES - YIELD

Irrigation: 100% 20% 100% 20%

NO EFFECT OF FERTIGATION ON YIELD

ON AVERAGE > 2.5 TON MORE YIELD DUE TO IRRIGATION
STRAWBERRIES – VEGETATION INDICES

PSSRb index good correlation with final yield.

- 100% irrigation
- 80kg N
ORCHARDS – YIELD ESTIMATION

0°  30°  60°  90°
ORCHARDS – APPLE DETECTION

Superpixel segmentation

Color filter

CNN

Binary images
ORCHARDS – ‘RED DELICIOUS’ DETECTION

17%  

18%
ORCHARDS – ‘GRANNY SMITH’ DETECTION

30 %

30 %
## RESULTS – APPLE COUNTING

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>$0^\circ$ R²</th>
<th>$0^\circ$ RMSE</th>
<th>$30^\circ$ R²</th>
<th>$30^\circ$ RMSE</th>
<th>$60^\circ$ R²</th>
<th>$60^\circ$ RMSE</th>
<th>$90^\circ$ R²</th>
<th>$90^\circ$ RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gala</td>
<td>0.59</td>
<td>67</td>
<td>0.74</td>
<td>55</td>
<td>0.60</td>
<td>68</td>
<td>0.13</td>
<td>100</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>0.54</td>
<td>56</td>
<td>0.70</td>
<td>45</td>
<td>0.53</td>
<td>58</td>
<td>0.16</td>
<td>76</td>
</tr>
<tr>
<td>Pink Lady</td>
<td>0.48</td>
<td>38</td>
<td>0.33</td>
<td>43</td>
<td>0.46</td>
<td>38</td>
<td>0.12</td>
<td>49</td>
</tr>
<tr>
<td>Granny Smith</td>
<td>0.66</td>
<td>21</td>
<td>0.53</td>
<td>25</td>
<td>0.59</td>
<td>23</td>
<td>0.41</td>
<td>28</td>
</tr>
<tr>
<td>Alle cultivars</td>
<td>0.71</td>
<td>56</td>
<td>0.74</td>
<td>53</td>
<td>0.68</td>
<td>59</td>
<td>0.28</td>
<td>88</td>
</tr>
</tbody>
</table>
# PEAR ORCHARDS – NUTRIENTS: EXPERIMENTAL SETUP

## Object % D.S. mg/100 g vers gewicht

<table>
<thead>
<tr>
<th>Object</th>
<th>Nitrogen</th>
<th>Phosphor</th>
<th>Potassium</th>
<th>Magnesium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KNO₃</td>
<td>40 E</td>
<td>-</td>
<td>20 E</td>
</tr>
<tr>
<td>2</td>
<td>Slurry</td>
<td>-</td>
<td>40 E</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Digestant</td>
<td>-</td>
<td>40 E</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Liquid N</td>
<td>40 E</td>
<td>20 E</td>
<td>-</td>
</tr>
</tbody>
</table>

### Streefwaarden

<table>
<thead>
<tr>
<th>mg/100 g vers gewicht</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9-3.7</td>
</tr>
<tr>
<td>0.2-0.5</td>
</tr>
<tr>
<td>1.5-2.5</td>
</tr>
<tr>
<td>0.9-2.0</td>
</tr>
<tr>
<td>0.25-0.5</td>
</tr>
</tbody>
</table>

## Object mg/100 g vers gewicht

<table>
<thead>
<tr>
<th>Object</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.9</td>
<td>0.11</td>
<td>0.52</td>
<td>2.48</td>
<td>0.46</td>
</tr>
<tr>
<td>2</td>
<td>1.9</td>
<td>0.13</td>
<td>0.61</td>
<td>2.37</td>
<td>0.46</td>
</tr>
<tr>
<td>3</td>
<td>1.9</td>
<td>0.12</td>
<td>0.56</td>
<td>2.17</td>
<td>0.44</td>
</tr>
<tr>
<td>4</td>
<td>1.9</td>
<td>0.12</td>
<td>0.57</td>
<td>2.29</td>
<td>0.46</td>
</tr>
</tbody>
</table>

### Streefwaarden

<table>
<thead>
<tr>
<th>mg/100 g vers gewicht</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0-2.5</td>
</tr>
<tr>
<td>&gt; 0.14</td>
</tr>
<tr>
<td>&gt; 0.90</td>
</tr>
<tr>
<td>&gt; 1.50</td>
</tr>
<tr>
<td>&gt; 0.23</td>
</tr>
</tbody>
</table>
PEAR ORCHARDS – NUTRIENTS
PHOTOSYNTHESIS AND FLUORESCENCE

Incoming PAR

Reflected PAR

Transmitted PAR

Absorbed PAR

Non-photosynthetic pigments

Photosystems II

Photosystems I

Fluorescence

Fluorescence

Heat

Heat

LET

CET

Alternative Electron Sinks

ATP, NADPH

ATP

LIGHT REACTIONS

CARBON REACTIONS

Photorespiration

Alternative Pathways

Gross Photosynthesis, GPP

Leaf Respiration

Net Photosynthesis, NPP

GPP = LUE × PAR × PAR

Absorption

Chlorophyll-Fluorescence

Reflectance

Transmittance

Chlorophyll-Fluorescence

Photosynthesis
PHOTOSYNTHESIS AND FLUORESCENCE

Fluorescence induction curve: OJIP-
Strawberry (*Fragaria*): 20 leaves of each plot, two measurements per leaf, two plots per treatment → total measurement/treatment: 80; in table, CCM-values (R.U.) and absolute in mg chl/gr FW

<table>
<thead>
<tr>
<th>Treatment N-fertilization-Irrigation-Fertilization</th>
<th>total (R.U)</th>
<th>chlorophyll</th>
<th>STDEV</th>
<th>Total chlorophyll mg/gr.FW</th>
<th>l</th>
<th>STDEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-100-0</td>
<td>12.0</td>
<td>2.6</td>
<td>1.4</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-100-40</td>
<td>13.3</td>
<td>2.5</td>
<td>1.7</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-100-80</td>
<td>11.6</td>
<td>2.4</td>
<td>1.6</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-20-0</td>
<td>14.0</td>
<td>2.7</td>
<td>1.5</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-20-40</td>
<td>14.7</td>
<td>2.8</td>
<td>1.4</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-20-80</td>
<td>14.6</td>
<td>2.7</td>
<td>1.5</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-100-0</td>
<td>12.0</td>
<td>2.5</td>
<td>1.6</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-100-20</td>
<td>12.0</td>
<td>2.8</td>
<td>1.4</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-100-40</td>
<td>12.0</td>
<td>2.8</td>
<td>1.7</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No significant differences in chl-content between treatments.
**FLUORESCENCE ANALYSIS**

Fluorescence induction curve: OJIP-curve

- 30 min dark adaptation of leaves using leaf clips; two consecutive measurements
  - saturating light pulse 1, 1 sec: fluorescence induction curve, kinetics give information on performance of PSII
  - after 10 sec dark, second light pulse: different kinetics, information on recovery capacity

- $\varphi_{Po}$: maximal photochemical efficiency of PSII, vegetative stress indicator; other parameters information on function of PSII (for explanation, see appendix 1 in report)

- PI(abs) is the performance index expressed on an absorbance basis

- PI(abs) consists of three components derived from the JIP-analysis: (i) force due to active reaction centers; (ii) force of light reactions related to quantum yield of primary photochemistry and (iii) force related to dark reactions (beyond $Q_A$).

  $$\text{PI(abs)} = \frac{RC}{ABS} \left( \frac{\varphi_{P0}}{1-\varphi_{P0}} \right) \left( \frac{\psi_{0}}{1-\psi_{0}} \right)$$
Figure 6: typical set of fast fluorescence induction curves; x-axis is a logarithmic scale, y-axis: fluorescence signal in mV. Lower curve (sigmoidal shaped curve): pulse 1, upper curve: pulse 2. (The example is from a Strawberry leaf, plot A1).
Figure 7: OJIP analysis of the fast chlorophyll fluorescence induction, first pulse.
**FRAGARIA : PI(ABS) , NORMALISED**

Code: treatment

*N-fertilization-irrigation- fertigation*

» 1 = 0-100-0
» 2 = 0-100-40
» 3 = 0-100-80
» 4 = 80-100-0
» 5 = 80-100-40
» 6 = 80-100-80
» 7 = 80-20-0
» 8 = 80-20-40
» 9 = 80-20-80

the normalisator is treatment one, which obtained no fertiliser and no fertigation, fully irrigated.

Conclusion:
- N-fertilization improves PI(abs) (5-9)
- In fully irrigated treatments: higher PI(abs) with “middel” fertigation (2, 5)
- best improvement PI (abs): high N, low irrigation, high fertigation (8,9)
**PYRUS COMMUNIS: OJIP-ANALYSIS**

OJIP-analysis of fluorescence induction curves:
- object 1: KNO₃
- object 2: slurry
- object 3: digestate
- object 4: liquid N

The normalisator is object one.
CONCLUSIONS

» The so called vegetative stress indicator $\Phi_P (\text{PHI}(P_o))$, the maximal photochemical efficiency of photosystem 2, is not affected by any treatment.

» The PI is an indicator of sample vitality and is an expression indicating the internal force for of a sample (e.g. leaf) to withstand constraints from outside. PI(abs) consists of three components: (i) force due to active reaction centers; (ii) force of light reactions related to quantum yield of primary photochemistry and (iii) force related to dark reactions (beyond QA-).

» In Fragaria: although no differences in chlorophyll content can be noticed, the best improvement of the PI (performance index) is obtained with high N-fertilization, low irrigation and high fertigation (80-20-40/80-20-80); this can be an indication that the treatments result in change in structural/functional characteristics of the photosynthetic machinery.

» In Pyrus communis: no differences in chlorophyll content can be noticed, no effect of treatment on the performance index. This in contradiction to previous measuring campaign where slurry, digestate and liquid N improves the PI (abs). A possible explanation is that the trees (efficiency of the photosynthetic apparatus) have been adapted to the over the years repeated treatments; this does not mean that specific treatments will not result in increased production.

» Chlorophyll fluorescence imaging: analysis still in progress.
Part II: Soil mapping

BELAIR WORKSHOP 2016 - NOVEMBER 8, 2016 - BRUGES, Belgium

Bas Van Wesemael and Fabio Castaldi
SOIL CARBON PREDICTION IN CROPLANDS – PROSOIL PROJECT

- Soil sampling
  - Lab analysis
  - Lab spectra
  - Spectral data at sampling points
  - Multivariate model
    - Predicted values
    - Validation
    - OC Map
- LUCAS
  - Multivariate model
  - Airborne image APEX
  - OC values (truth)
SOIL CARBON PREDICTION IN CROPLANDS - HESBANIA

Soil sampling
Lab analysis
OC values (truth)

Airborne image APEX
Spectral data at sampling points

Multivariate model
OC Map
Flight time 01/07/2015 collecting ASD spectra of bare soils
APEX IMAGES

APEX image
285 bands
412 - 2430 nm

Bare fields

Vegetation mask
SOC index \( \frac{(R_{630} - R_{2230})}{(R_{630} + R_{2230})} \)
SAMPLING STRATEGY

61 samples
ORGANIC CARBON CONTENT – G KG-1

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>10.5</td>
</tr>
<tr>
<td>Min</td>
<td>7.1</td>
</tr>
<tr>
<td>Max</td>
<td>19.4</td>
</tr>
<tr>
<td>SD</td>
<td>2.3</td>
</tr>
</tbody>
</table>
APEX SPECTRA

Examples of soil spectra

Bilinear interpolation
Partial Least Square model 2013 - Leave one out cross validation

Spectra transformation = absorbance
N° components = 10

RMSE = 0.6 g kg\(^{-1}\)
RPD = 2.2

RPD: std/RMSE
PLSR model 2015 - LOOCV

Spectra transformation = absorbance
N° components = 14

RMSE = 0.9 g kg\(^{-1}\)
RPD = 2.5
CONCLUSIONS

• The sampling strategy allowed to have a quite large OC variability
• PLSR model provided good prediction accuracy
• Maps show clear OC patterns within the fields

Future research and practical applications

• Site specific management according OC patterns (Precision Agriculture)
• To improve the prediction accuracy using LUCAS spectral library (PROSOIL)
Part III: Annual crop monitoring

BELAIR WORKSHOP 2016 - NOVEMBER 8, 2016 – BRUGES, Belgium

Viviane Planchon, Yannick Curnel, Fériel Ben Abdallah, Jean-Pierre Goffart (CRA-W), Isabelle Piccard (VITO), Cindy Delloye (UCL)

Thanks to Amaury Le Clef, William Philippe – CRA-W
Tom Verstappen (UAV pilot), Johan Mijnendonckx (UAV pilot), Pieter-Jan Baeck (UAV processing) - VITO
BELAIR 2015 has allowed obtaining the required observations to meet the research objectives of the projects:

1. iPot
2. BELCAM
3. CRA-W 2015 potato trial

The in-situ measurements as well as the processing of the data were carried out by CRA-W, UCL and VITO.

UAV flights were carried out by VITO.
Specific Objectives

to acquire UAV’s observation needed in the STEREO III
(1) BELCAM project (collaborative system for agricultural monitoring)
(2) iPot project (industrial potato monitoring for the Belgian potato sector)
and
the CRA-W 2015 potato trial: to continue BELAIR 2013 researches related to the optimization of nitrogen fertilization through a fine assessment of in-season crop nitrogen status (CNS) and to evaluate the potential use of UAV’s optical devices to assess potato crop nitrogen status.
WHAT : LINK WITH BELSPO PROJECT

iPot and Belcam projects

Both funded by BELSPO (BELgian Science Policy Office)

**iPot**
- 36 months (06.2014-05.2017)
- Application project
- Crop: Potato

**BELCAM**
- 54 months (10.2014-03.2019)
- Thematic research project
- Crops: Potato, winter wheat and maize
WHAT: LINK WITH BELSPO PROJECT

Industrial Potato monitoring for the Belgian potato sector
Development of geo-information products for both the Belgian potato processing industry and research centres on potato crop, as an answer to the industry’s specific needs regarding crop condition, growth monitoring and yield estimates and forecasts

Products satellite-based BUT detailed UAV images used as an intermediate level between field and satellite and help to define the required characteristics of the input satellite images and serve as a reference for high resolution satellite data interpretation through the Geo-web-based platform

Availability of UAV’s time series images: very important around phenological periods (emergence/senescence) that are of prime importance to predict final potato yield and to determine the optimal date for harvest

HUGE need for UAV’s data to validate satellite data that is the basic source of information across the whole Belgian territory to manage the potato crop fields at the end of the project through the Geo-web-based platform
WHAT: LINK WITH BELSPO PROJECT

BELgian Collaborative Agriculture Monitoring at parcel level for sustainable cropping systems
WHAT : LINK WITH BELSPO PROJECT

Design of collaborative information system built on the complementarity of local (professional crowdsourcing) and satellite remote sensing technologies for crop monitoring

By fully exploiting the red-edge capabilities of Sentinel 2 and the wide and frequent coverage of Sentinel 1 and 2 as well of PROBA-V, different information will be delivered along the season to the farmers:
1) the provisional annual Nitrogen balance-sheet
2) the field zoning
3) the crop Nitrogen status before the 3rd application for winter wheat and before a potential second application for potato at the parcel level

In addition, the overall crop status along the season, the major water stress/pest/diseases damages and the yield estimate will be provided at the district level
Field observations
- one winter wheat field and three potato fields in Gembloux for BELCAM and iPot projects
- a potato field was monitored for the CRAW 2015 potato trial
HOW : IN-SITU CAMPAIGNS

iPot and BELCAM : potato reference fields

3 potato fields monitored in 2014-15 in Gembloux area

Variety : Fontane, Nicola, Bintje

Ground observations :
- Phenological development stage (2-decimal BBCH code)
- Hemispherical pictures (DHP - fCover, fAPAR and LAI)

- Dualex at senescence

Geodata collected as close as possible to the UAV flight dates
<table>
<thead>
<tr>
<th>DMC</th>
<th>UAV</th>
<th>DHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 May 2014</td>
<td>28 May 2014</td>
<td></td>
</tr>
<tr>
<td>6 June 2014</td>
<td>6 June 2014</td>
<td></td>
</tr>
<tr>
<td>23 June 2014</td>
<td>17 June 2014</td>
<td>17 June 2014</td>
</tr>
<tr>
<td>3 Sept 2014</td>
<td>4 Sept 2014</td>
<td>22 May 2015</td>
</tr>
<tr>
<td>4 June 2015</td>
<td>22 May 2015</td>
<td>5 June 2015</td>
</tr>
<tr>
<td>11 June 2015</td>
<td>11 June 2015</td>
<td>11 June 2015</td>
</tr>
<tr>
<td>14 June 2015</td>
<td></td>
<td>24 June 2015</td>
</tr>
<tr>
<td>1 July 2015</td>
<td>1 July 2015</td>
<td>1 July 2015</td>
</tr>
<tr>
<td>11 July 2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Aug 2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 Aug 2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Sept 2015</td>
<td>4 Sept 2015</td>
<td></td>
</tr>
</tbody>
</table>

**HOW: AIRBORNE AND SPACEBORNE CAMPAIGNS**

3 potato fields monitored in 2014-15 in Gembloux area by UAV at
- emergence: RGB
- senescence: RGB+MS
BELCAM project: winter wheat trial

40 varieties and 2 levels of Nitrogen (recommended application and additional 50 kg of Nitrogen)

Five varieties (Edgar, Expert, Cellule, Sahara, Tobak) were selected for the study according to the following criteria:
(1) representative variety of those used by the Belgian farmers
(2) variability in the varieties in terms of precocity, resistance, structure having a potential influence on the chlorophyll content

Data collected on the 20/05/2015
Potato trial 2015 (CRA-W)

Crossing nitrogen rates and irrigation modalities (split plot design)

- two levels of water (irrigated, non-irrigated) - Irrigation scheduling was conducted based on the soil water content which is monitored using soil tensiometer probes
- four levels of fertilisation (0, 100, 150, 250 kg N/ha) - nitrogen rates were applied at planting

1 variety: Charlotte
HOW : IN-SITU CAMPAIGNS

Potato trial 2015 (CRA-W)

Other observations:
- ASD radiometer for chlorophyll
- Hemispherical pictures for LAI assessment

Observations: 29/6/2015

Chlorophyll meter
SPAD/HNT
Transmittance

Radiometer
Cropscan
Réflectance

Index HNT

Estimation of leaf [chlorophyll]

Indices G et NormG
Indices R et NormR
Indices NIR et NormNIR
Indices NDVI et GNDVI
Indices SAVI et GSAVI...
Potato trial 2015

**Plant sample collection and analysis**
- Phenological observations (BBCH code)
- Roots and tubers fresh weight
- Biomass and water content, DM content
- Analytical measurements of total N plant concentration conducted (NIR spectroscopy)
- Calibrated using the Dumas Combustion method
- LAI (by destructive measurements), image analysis, reflectance of the leaves (ASD)

Observation : 01/07/2015
RESULTS: UAV IMAGES

iPot and BELCAM: potato reference fields

Orthophotographs and DTM generated with Agisoft Photoscan (RGB, RE) or PostFlight Terra (Multispec4C)

Bintje 2014 (GM)  Fontane 2014 (PL)  Bintje 2014 (SV)

Bintje 2015  Fontane 2015  Nicola 2015

Examples for 1 date
RESULTS: DMC SATELLITE IMAGES

- TOC reflectances
- NDVI
- \( f_{\text{APAR}} \)
- \( f_{\text{Cover}} \)
- LAI
- Cloud/shadow mask

22m resolution

Emergence → Senescence →

INRA-EMMAH algorithm
RESULTS: DMC-FCOVER VALIDATION RESULTS

Comparison of DMC and UAV fCover images for 2014 and 2015 for:
- Buffered fields
- Exact dates only
- At 25m resolution
- 3x3 filter applied on UAV

EXAMPLE: FONTANE, 1/7/2015

Classification: veg/no veg
fCover: % veg in 25m pixels

Table:

<table>
<thead>
<tr>
<th></th>
<th>R2</th>
<th>RMSE</th>
<th>MAE</th>
<th>MEAN DMC</th>
<th>MEAN UAV</th>
<th>STDEV DMC</th>
<th>STDEV UAV</th>
<th>OBS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.97</td>
<td>0.06</td>
<td>0.04</td>
<td>0.55</td>
<td>0.54</td>
<td>0.29</td>
<td>0.30</td>
<td>494</td>
</tr>
</tbody>
</table>
RESULTS: DMC-FAPAR VALIDATION RESULTS

Example: Bintje, 2015

\[ y = 1.2681x - 0.199 \]
\[ R^2 = 0.9648 \]

\begin{tabular}{c c c c c c c}
  R2 & RMSE & MAE & MEAN SAT & MEAN DHP & STDEV SAT & STDEV DHP & OBS \\
  0.96 & 0.10 & 0.08 & 0.63 & 0.60 & 0.28 & 0.36 & 109 \\
\end{tabular}
RESULTS: RAPIDEYE SATELLITE IMAGES

- Quality control:
  - TOC reflectances
  - NDVI
  - fAPAR
  - fCover
  - LAI
  - Cloud/shadow mask

@ 5m resolution
Comparison $f_{\text{Cover}}$ / $f_{\text{APAR}}$ satellite vs UAV / DHP

- Comparable accuracy for $f_{\text{Cover}}$ and $f_{\text{APAR}}$:
  - profiles look fine
  - slight overestimation at emergence

- $f_{\text{Cover}}$: comparable results for DHP and UAV approaches
FEEDBACK

» **Positive:**
  » Lots of data
  » Nice collaboration – many teams
  » Many outreach possibilities
  » Unique high spatial multitemporal information

» **Needs:**
  » Dedicated project call needed for the analysis of the Belair data at the time of the Belair campaign call - time lag between collection and data analysis has to be avoided
  » Interactive database with programming interface would be very useful
  » Hyperspectral data
Field observations
- one winter wheat field and three potato fields in Gembloux for BELCAM and iPot projects
- a potato field was monitored for the CRAW 2015 potato trial
WHERE: STUDY AREA: APEX ACQUISITION 2015

iPot: Bintje
iPot: Nicola

Potato trial: Charlotte 2015
Belair Hesbania is the flower
You’ve got to let it grow.

Adapted from John Lennon - Mind Games