Industrial potato monitoring

The Bright Side of Remote Sensing Workshop
25 October 2016, Brussels

Jean-Pierre Goffart, CRA-w
Isabelle Piccard, VITO

With contributions from Romain Cools, Nele Cattoor, Yannick Curnel, Amaury Leclef, Viviane Planchon, Joost Wellens, Bernard Tychon, Anne Gobin, Jeroen Dries, Jürgen Decloedt
Context of the potato crop in Belgium

• Current situation:

Fast developing sector, world leader for frozen potato products, high-tech processing industry

• Request for new development
Global objectives

• To provide the Belgian processing and fresh potato sectors with near real time information at field or district level, regarding growing conditions (soil, weather), crop development status and early yield estimation/prediction based on use of satellite images time series and crop growth simulation models.

• To develop a web-platform with geolocalized data allowing growers and industry (fresh and processed potato), together with research and technical centers, to analyse and combine those data with fields observations, aiming to improve management decision during growing season and at harvest and storage of the tubers for several months.

• Finally, to improve potato fields monitoring over the whole production area, leading to higher volume and quality
Crop monitoring at field scale aims at...

- **Crop phenology monitoring** ...

  **Key stages are:**

  - **Emergence** to improve crop growth simulation models
  - **Senescence** to help decision on haulm killing and harvest planification
...and aerial biomass status monitoring

• To compare crop growth and development between fields during the growing season (*Normal? Faster? Slower?*)

• To analyse intra-field variability (*helpful for invasive tuber sampling and modulation of fertilizer-N application*)

• To detect field anomalies linked to drought, water logging/flooding, pest or diseases (*hampered or delayed growth*)
Methodology for crop monitoring at field scale

- **Satellite images (high resolution)**
  - DMC Deimos/ Sentinel-2
  - At country scale
  - 10 m (Sentinel) - 25 m (DMC) spatial resolution
  - +/- weekly acquisitions

  -> Derivation of **Vegetation Indices** (VIs) expressing the productivity of the crop ("greenness indices"): 

  - $f_{APAR}$  Fraction of Absorbed Photosynthetically Active Radiation
  - $f_{COVER}$  Fraction of Green Vegetation Cover
Field observations

- **Field observations**
  - Geographic coordinates
  - Field area
  - Tubers sampling *(every two weeks for yield assessment starting July)*

- **Phenological stages follow up**
  - BBCH scale (2-digits)
  - Every 2 weeks

- **Specific events detection:**
  - Waterlogging / flooding
  - Drought
  - Pest and diseases
  - ...

MSA-12 (08/06/2016)
Weather data

- Temperature
- Precipitation

Useful
- To monitor field conditions
- To interpret crop behavior
- To run crop growth simulation models

Available on the iPot WEB TOOL
2 field campaigns (2015-2016)

Varieties: Bintje, Fontane (processing) and Nicola (fresh market)
Varieties: Bintje, Fontane (processing) and Nicola (fresh market)
Validation of satellite info

- 3 UAV monitoring campaigns (2014-15-16) in 3 fields (1 per variety)
- In Gembloux area – eBee with a RGB/MSpec Camera
- Comparison of indices derived from satellite vs. UAV and ground measurements (DHP)
Yield estimation / prediction at field scale

- Yield estimation/prediction are expected to be improved with the assimilation of satellite derived-data into the models
- Aims at harvest and storage planification + benchmarking

**CROP GROWTH SIMULATION MODELS**

- **Emergence date (satellite)**
- **Observed yield « Calibration » set**
- **Senescence date (satellite)**
- **Historical meteorological data**

**Forcing**

**Recalibration**

**Updating**

**Observed yield « Validation » set**

**Comparison of observed and simulated yields**

**Comparison of simulation models and selection (ongoing)**
Yield estimation / prediction

- Crop growth models tested: AQUACROP, WOFOST, LINTUL-POTATO-DSS
Yield estimation / prediction

• Crop growth models tested: AQUACROP, WOFOST, LINTUL-POTATO-DSS

Needs for re-calibration / validation data set

Field data:
- Geolocalisation
- Phenology
- Tubers samples
- Irrigation
- ...

HiRes Satellite images
and Sentinel-2!
Field & crop monitoring

- Time series of satellite images:
  - DMC/Deimos (22m, since 2009)
  - Sentinel-2 (10m, since Aug 2015)

- Indices:
  - fAPAR
  - fCover

Processing by VITO:
- Atmospheric correction (OPERA)
- Cloud & shadow detection
- Calculation of biopar’s (INRA-EMMAH algorithms)
Crop growth monitoring

Emergence → based on “greenness index” (fAPAR)

1 May 2016
8 May 2016
28 May 2016
6 June 2016
10 July 2016
20 July 2016
9 Aug 2016

Senescence →

5 Sept 2016
8 Sept 2016
15 Sept 2016
25 Sept 2016
28 Sept 2016
5 Oct 2016

Use of this info:
• Field management
• Planning / logistics
• Input for yield models
Variability (in season)

**Variability between fields:**
Due to early varieties (in blue) vs. late varieties (in red) or to different planting dates or events

**Sentinel-2 of 23 June 2016**

**Variability within a field:**
- Allows Variable Rate Applications (fertilizers, irrigation,...) -> Management Zones
- Definition of tubers sampling strategy (ground truth)
Variability (end of season)

- **Variability between fields:**
  
  Senescence started? Haulm killing applied? -> harvest planning

- **Variability within a field:**
  
  - haulm killing: variable rate application
  
  - where to take yield samples?
• Heavy rainfall in June 2016: water logging, flooding...

**UAV image of 18 July 2016 (RGB, 3 cm)**  
**UAV image of 18 July 2016 (NDVI, 8 cm)**  
**Sentinel-2 of 20 July 2016 (10m)**

fCover < 50%: crop lost or severely damaged
Validation fCover

• Comparison with UAV derived fCover estimates

Example: Bintje, 22/8/2015

Classification: veg/no veg

fCover: % veg in 10m pixels

First S2 results
5 Aug 2015
22 Aug 2015

DMC results (2014-15)

<table>
<thead>
<tr>
<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>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>
Validation fCover

- Comparison with DHP derived fCover estimates
  - Per field *(see examples)*
  - Per block

**GM - Bintje, 2014**

**PL - Fontane, 2014**

**SV - Bintje, 2014**

**Bintje, 2015**

**Fontane, 2015**

**Nicola, 2015**

**Bintje, 2016**

**Fontane, 2016**

**Nicola, 2016**
Validation fAPAR

- Comparison with DHP derived fAPAR estimates: per field & per block (see examples)

Bintje, 2015
Development of web application, *in progress*

**Target users:**
- Industry
- Farmers
- Advisors
- Research centres
Outlook

• **Updates:**
  - Validation of S2 & DMC fAPAR & fCover for 2016
  - Intercalibration S2 & DMC
  - Finetuning yield models

• **Webtool** improvement & further testing

• Start of **Promotional campaign** at Interpom Primeurs (27-29 Nov 2016 in Courtrai/Kortrijk, B)

• Official **launch of the iPot service**: March 2017
Thank you!

Eat Belgian fries!