Accuracy assessment of GAI retrieval from SPOT5 Take5 according to crop type and crop development (BELCAM)

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Background

BELCAM is a research project designed to exploit the new Copernicus satellites in the most relevant way for Belgian agriculture stakeholders. Building on the complementarity of satellite remote sensing technologies and local farm-sourcing, one of the research question is to investigate the sources of performance variability of the biophysical variables (BV) retrieved from remote sensing such as Green Area Index (GAI), fAPAR, biomass and chlorophyll content. Those BV are of major importance to estimate the Nitrogen content at the field scale and deliver practical information to the farmers on the Nitrogen status of the crops. BELCAM focuses on two crops for the Nitrogen advices : winter wheat and potato.

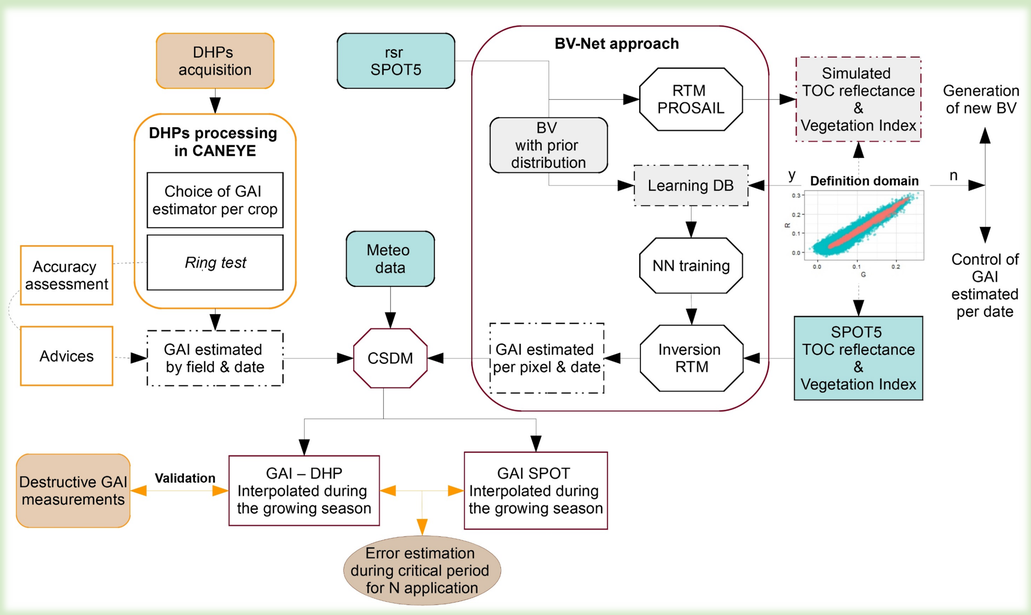
Objectives

One of the approach developed is the estimation of the total chlorophyll content (GAI x Cab) based on the application of an artificial neural network (NN). The main objective is therefore to study the accuracy of the GAI retrieved by the inversion of the NN for wheat and potato at the field scale with SPOT5 Take5 images of 2015.

Methodology

The methodology is divided in three main parts:

- Validation of the calibration data set acquired via DHP by (1) destructive measurements and (2) tests inter & intra users with CANEYE (*Ring test*);
- Calibration of the NN by crop based on the field data interpolated in time with a Canopy structural dynamic model (CSDM);
- Comparison of performances between crops, by varieties and according to the critical periods for Nitrogen application.



Conclusions

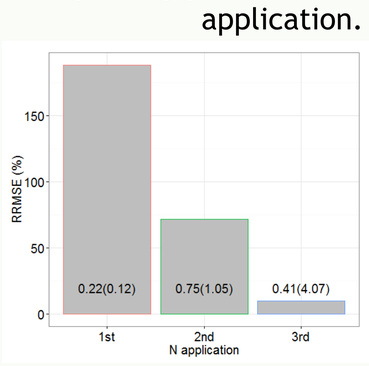
- The combination of simple vegetation indices (NDVI and NDWI) increases the accuracy of GAI estimated by a NN for the winter wheat by decreasing the residual noise in remote sensing data.
- The accuracy of the GAI retrieved for the winter wheat during the period of the third N application is promising for N recommandation (RRMSE = 10,2%).
- GAI of potato's varieties with high maximum GAI value (above 5) are underestimated by indirect methods (DHP and BV-Net) and may open the way for the use of fAPAR to estimate the total chlorophyll content in GAI saturating crop's.

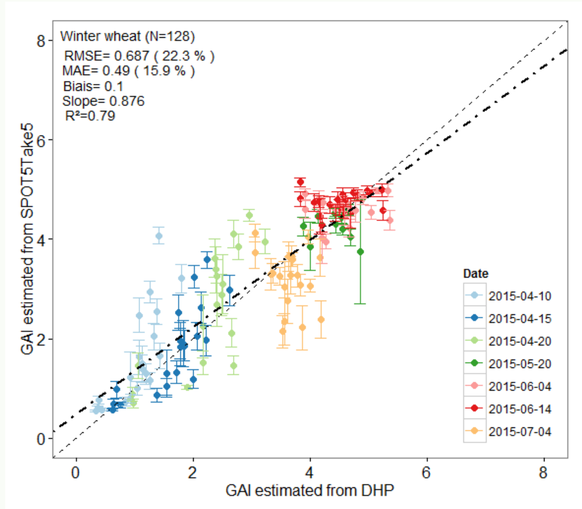
Simple vegetation indices improve the accuracy of GAI estimated - *Winter wheat*

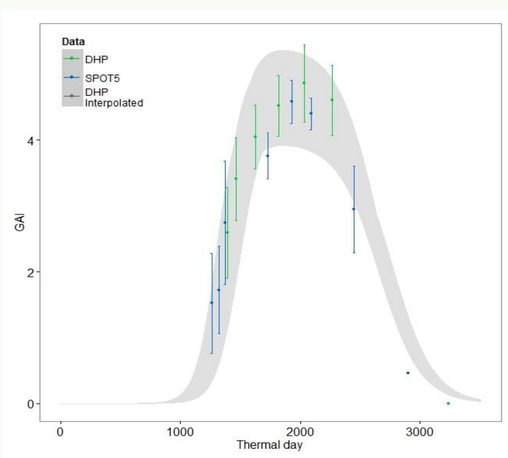
Accuracy assessment for several bands combination (date of SPOT5 images) based on BV-Net approach.

Spectral index	Bias	RMSE (RRMSE)	MAE (RMAE)	R^2 (slope)
R-G-NIR-SWIR	-0.44	1.1 (34.2%)	0.901 (29.0%)	0.74 (0.82)
G-NDVI-NDWI	0.10	0.69 (22.3%)	0.491 (15.9%)	0.79 (0.88)
NDVI - NDWI	0.16	0.70 (22.6%)	0.510 (16.5%)	0.78 (0.81)
NDWI – MTVI2	0.078	0.81 (26.3%)	0.662 (21.5%)	0.71 (0.61)
NDWI – MCARI	0.91	1.1 (34.6%)	0.922 (29.9%)	0.85 (0.85)

Evaluation of the GAI retrieved according to key periods for N application.

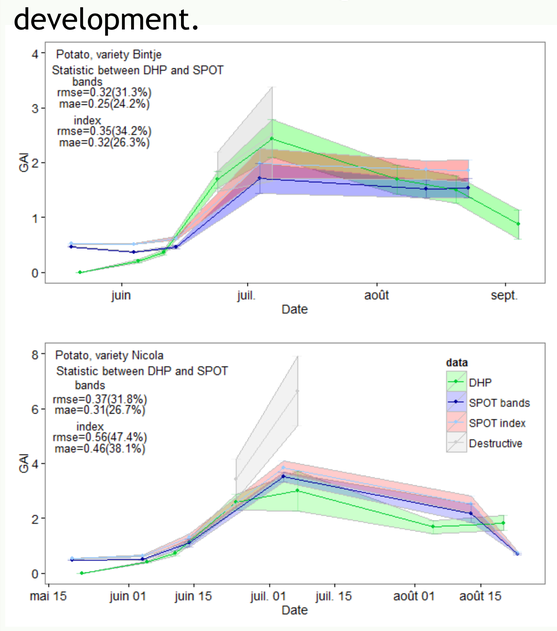






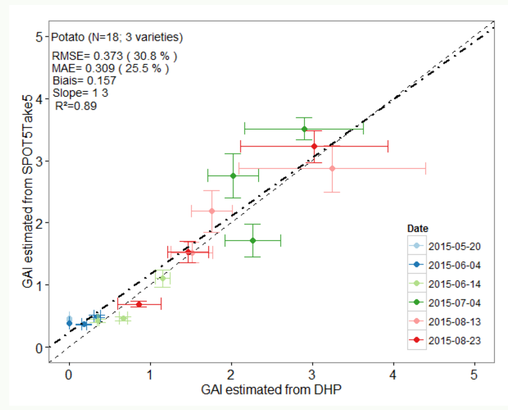
Differences in performance due to crop type and varieties *Potato*

Comparison of performance between potato varieties : underestimation of GAI for varieties with high development.



Comparison : best parameters applied for winter wheat vs potato.

Spectral index	Bias	RMSE (RRMSE)	MAE (RMAE)	R^2 (slope)
R-G-NIR-SWIR Potato specific	0 .16	0.37 (30.8%)	0.31 (25.5%)	0.89 (0.89)
G-NDVI-NDWI w. combination	0.39	0.56 (46.3%)	0.46 (37.7%)	0.89 (1.05)

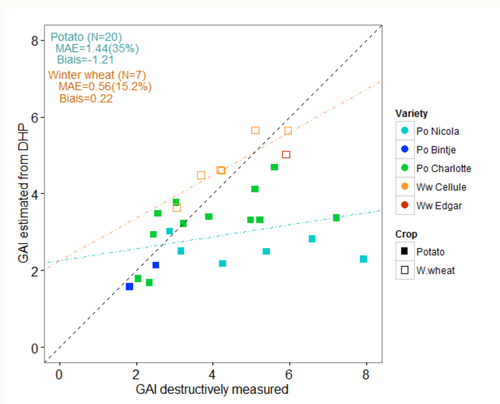


Validation of GAI estimated via indirect measurements (DHP)

Destructive measurements

Good performance : wheat even at high GAI value and potato at low development (Bintje).

Underestimation : potato at high development (from GAI>4).



Ring test

Good repeatability between users for the potato & intra-user for the wheat.
Higher variability in GAI estimation with the closing of the canopy cover and the flowering.