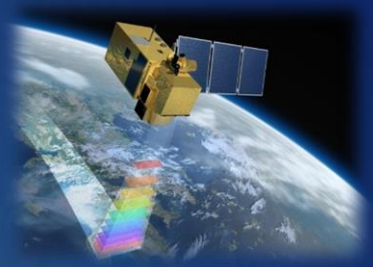
BEODay 2016

8th December



belcam

From 1st October 2014 to 31st March 2019

BELGIAN COLLABORATIVE AGRICULTURE MONITORING AT PARCEL LEVEL FOR SUSTAINABLE CROPPING SYSTEMS

Cindy Delloye (UCL)

with contributions from Defourny Pierre, Wellens Joost, Piccard Isabelle, Gobin Anne, Kristof Van Tricht, Goffart Jean-Pierre, Curnel Yannick, Goffart Dimitri, Planchon Viviane, Baret Fred, Weiss Marie, Jingyi Jiang

4 years BELSPO project covering 3 crops over the whole Belgium

- 5 scientific partners led by UCL and 8 pilot/technical centers

Belgian

Products at the belgian scale

Collaborative

IT platform

with …

Pilot & Technical Centers

Pionneers farmers

Agriculture Monitoring parcel level

3 crops

UCL Université catholique de Louvain

Université de Liège

vito vision on technology

cra-w

INRA SCIENCE & IMPACT

Partnership and collaborative system

First phase: learning phase

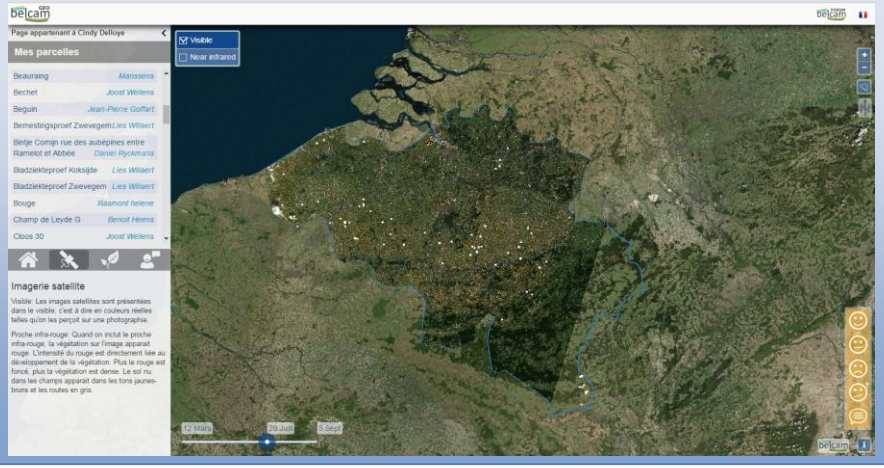
Products based on data rich model

Nitrogen advice

Development monitoring & anomalies detection

Yield estimation

Heterogeneity map



Field data

Feedback

NRT delivery

Carah – Centre pour l'agronomie et l'agro-industrie de la province de Hainaut

asbl Cadco

FIWAP asbl – Filière Wallonne de la Pomme de Terre

CIPF a.s.b.l.

inagro

LCG

pca

Provincie Antwerpen Hooibeekhoeve

Partnership and collaborative system
Second phase: pioneers farmers integration



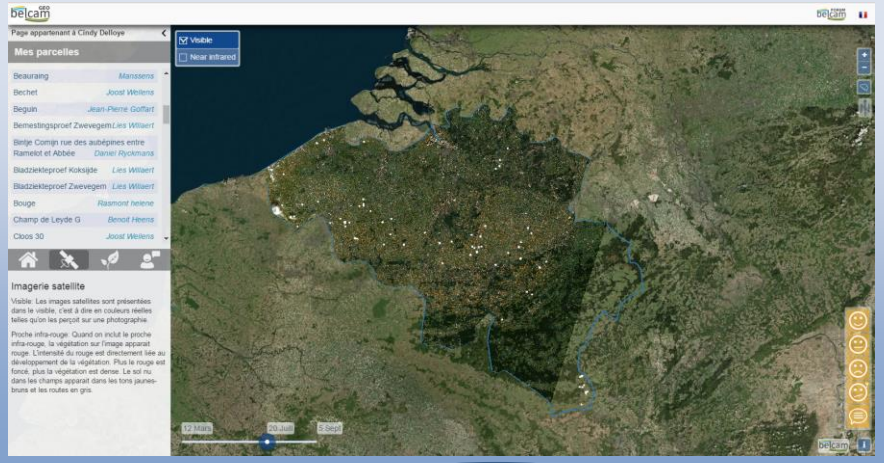
Products based on data rich model

Nitrogen advice

Development monitoring & anomalies detection

Yield prediction

Heterogeneity map



Field data

Feedback

NRT delivery

Pionneers farmers

Carah — CENTRE POUR L'AGRONOMIE ET L'AGRO-INDUSTRIE DE LA PROVINCE DE HAINAUT

asbl Cadco

FIWAP

CIPF a.s.b.l.

inagro

LCG

pca

PROVINCIE ANTWERPEN Hooibeekhoeve

First results

IMPROVEMENT OF THE NITROGEN ADVICE WITH SENTINEL IMAGES

Improvement of the Nitrogen advice with Sentinel images

- Objective: use of Sentinel data to improve the accuracy of the actual Nitrogen recommendation

Total N dosis
Requaferti

Complementary dosis
White book

Adjust the recommendation to the needs of the crops?

Is the last N dosis required ?

Input data

- Crop type & variety
- Soil characteristics
- Crop residues use
- Manure application frequency
- **Previous crop (type, yield)**
- **Cover crop type, biomass**
- **Cover crop ploughed/ not ploughed**
- …

From Sentinel

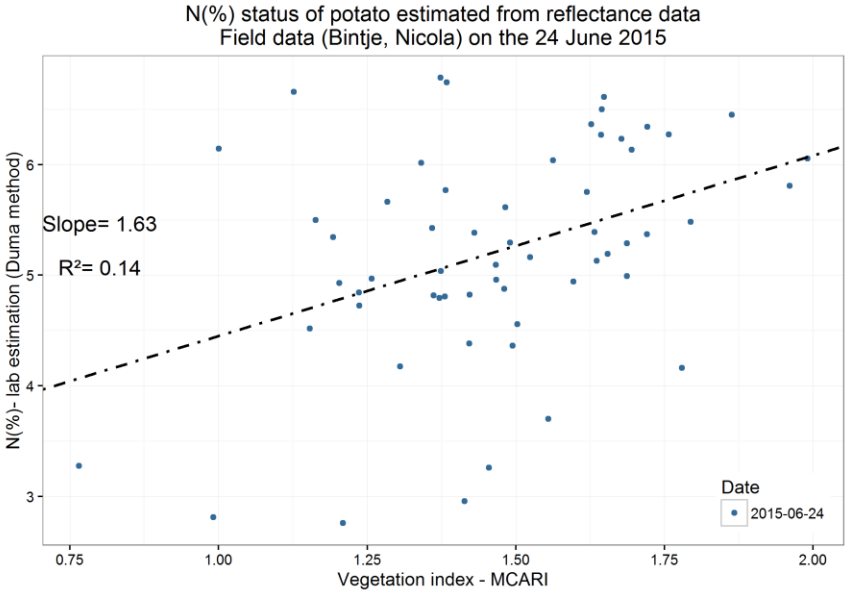
Estimated the current N status of the crop (winter wheat and potato)

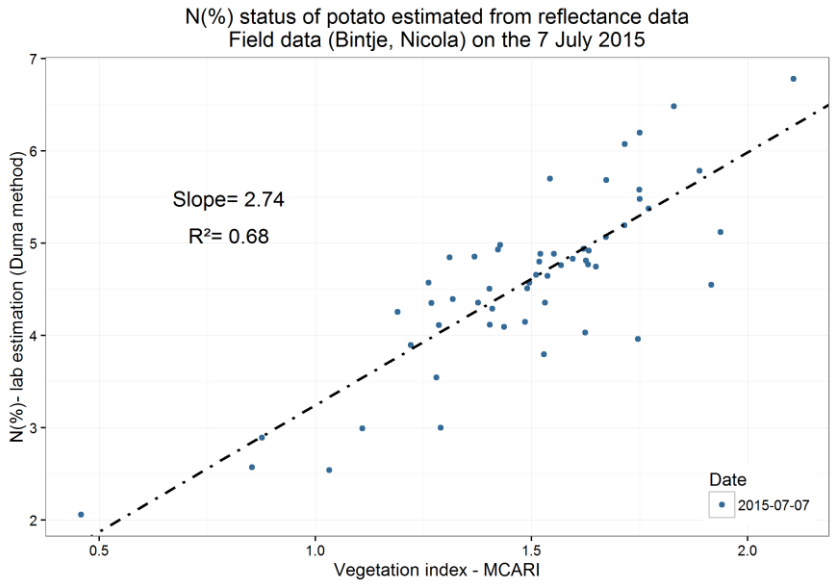
Estimation of the N status
Empirical model

Is the last N dosis required ?

Empirical relation

N_{canopy}

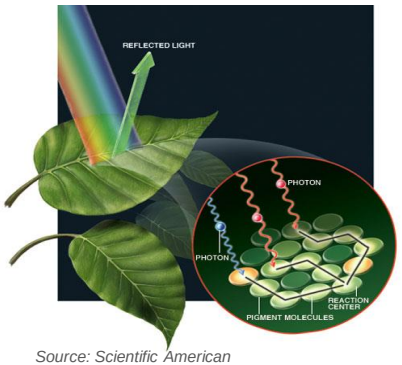




Date effect ?

Estimation of the N status
Radiative transfer model (1)

Is the last N dosis required ?

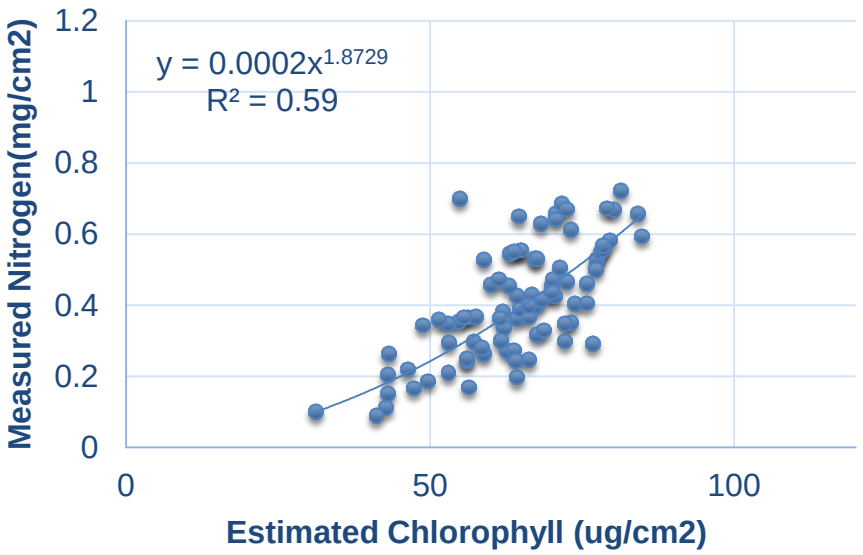


Source: Scientific American

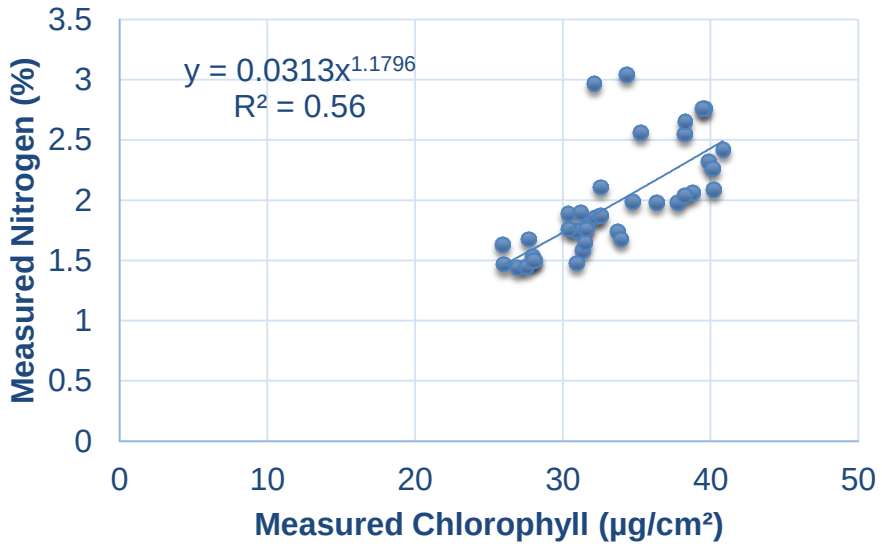
$$C_{ab,canopy} \leftrightarrow N_{canopy}$$

Relation N vs Chlorophyll

Leaf level (trial, INRA France)



Canopy level (field, Belgium)



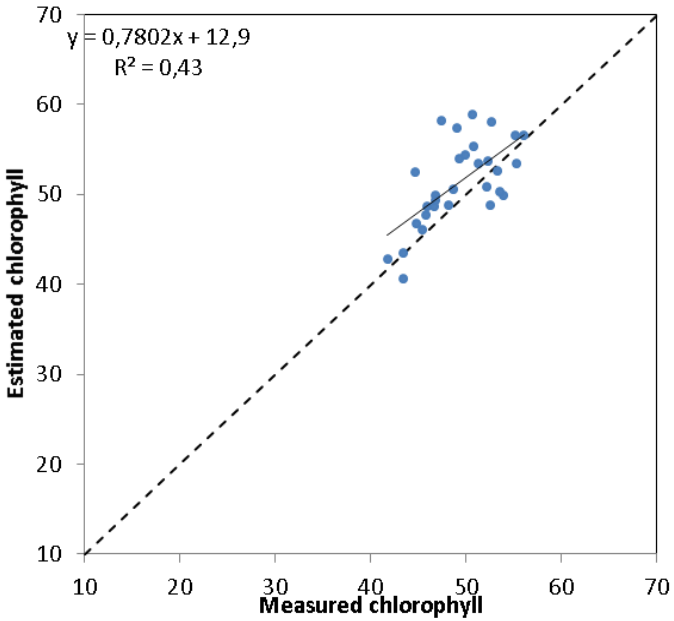
Estimation of the N status
Radiative transfer model (2)

Inversion of the RTM
Prospect model
(Jacquemoud & Baret, 1990)

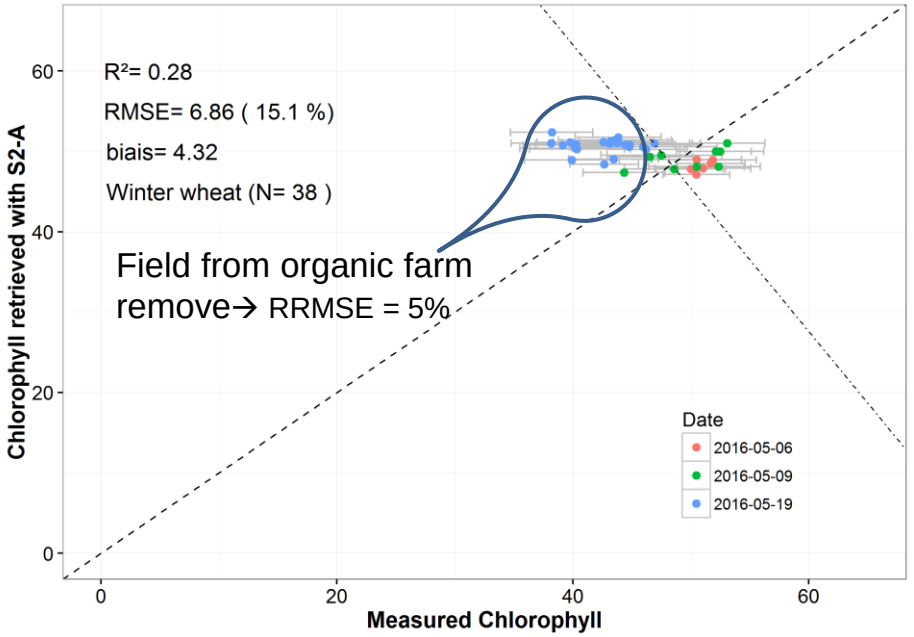
$$C_{ab,canopy} \leftrightarrow N_{canopy}$$

Relation Chl measured and estimated from RTM

Leaf level (trial, INRA France)



Canopy level (field, Belgium)



Previous crop (Requaferti input)
Crop type map 2015

Classifier comparison

K-nearest neighbours	Random Forest (100 trees)

Input: DMC/Deimos

- 8 March 2015
- 14 April 2015
- 4 June 2015
- 11 July 2015

Equal CAL/VAL data

OA = 83% **OA = 85%**

Similar accuracies in this test, but random forest allows to add more input data

Previous method **Current method**

Adding SAR data (and more optical)

→ **structural** information to classification in addition to **biophysical** information from optical data

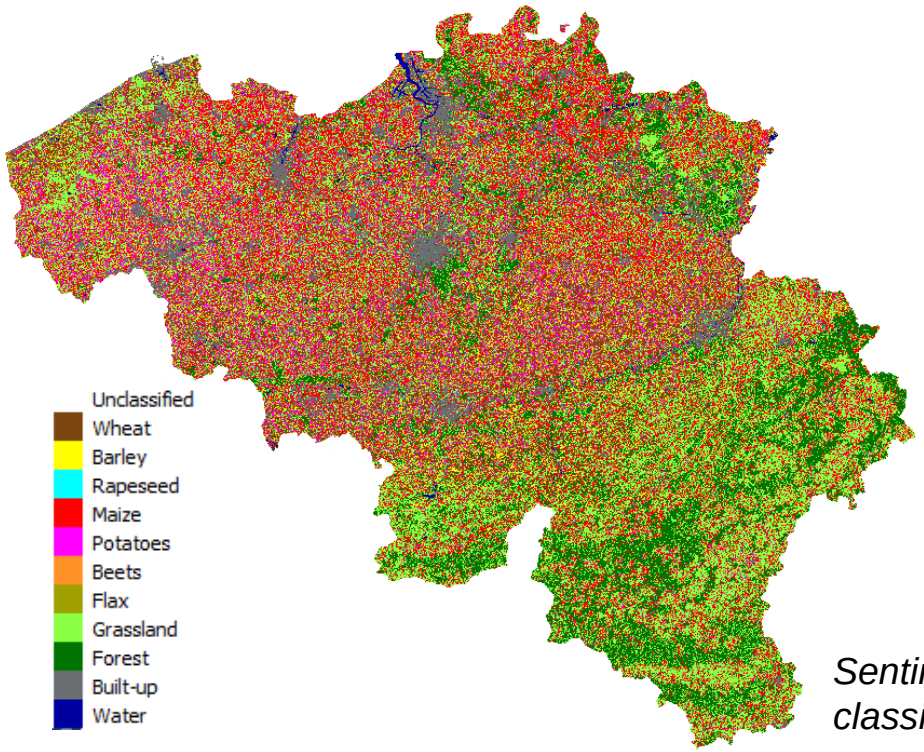
Especially interesting for early crop mapping

OA = 91%

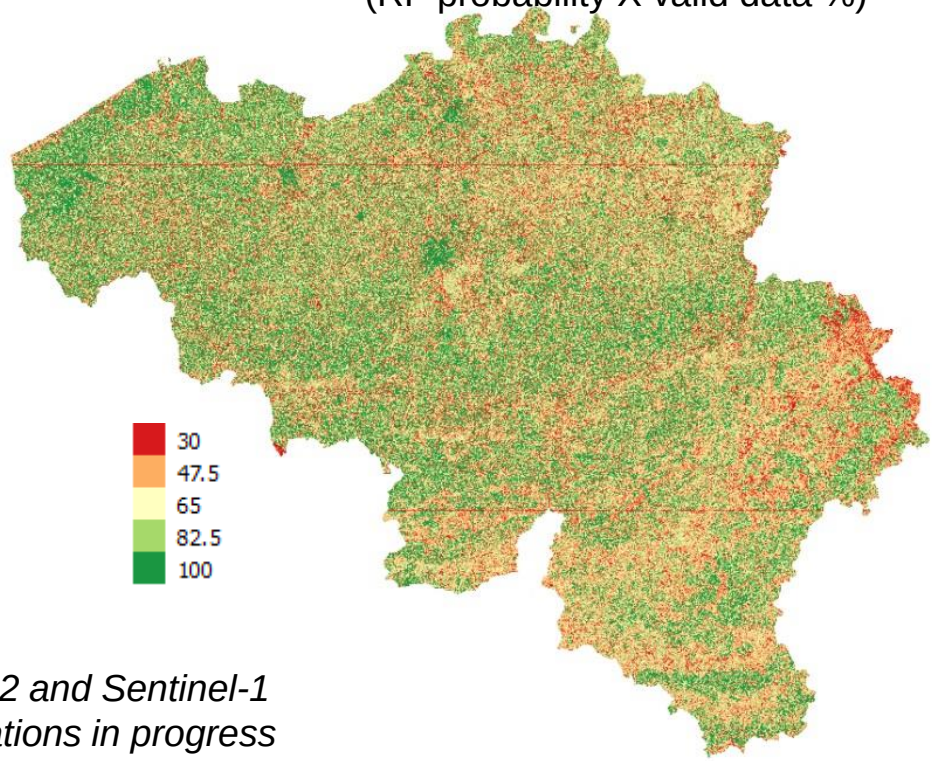
DMC					Sentinel 1			OA
8/03	14/04	4/06	11/07	1-7/08	Feb-Mar	May-Jun	Sep	
X								35%
X	X							59%
X	X	X						73%
X	X	X	X					84%
X	X	X	X	X				86%
					X			52%
					X	X		64%
					X	X	X	76%
X					X			70%
X	X				X			75%
X	X				X	X		75%
X	X	X			X	X		79%
X	X	X			X	X	X	85%
X	X	X	X		X	X	X	89%
X	X	X	X	X	X	X	X	91%

Previous crop (Requaferti input)
Crop type map 2016

Classification
DMC & Sentinel-1



Combined confidence (%)
(RF probability X valid data %)



Sentinel-2 and Sentinel-1 classifications in progress

	Wheat	Barley	Rape seed	Maize	Potatoes	Beets	Flax	Grass land	Forest	Built-up	Water
Confidence	82%	66%	55%	66%	62%	69%	69%	71%	60%	73%	54%
Accuracy	99%	92%	57%	94%	93%	86%	85%	94%	70%	79%	72%

First results

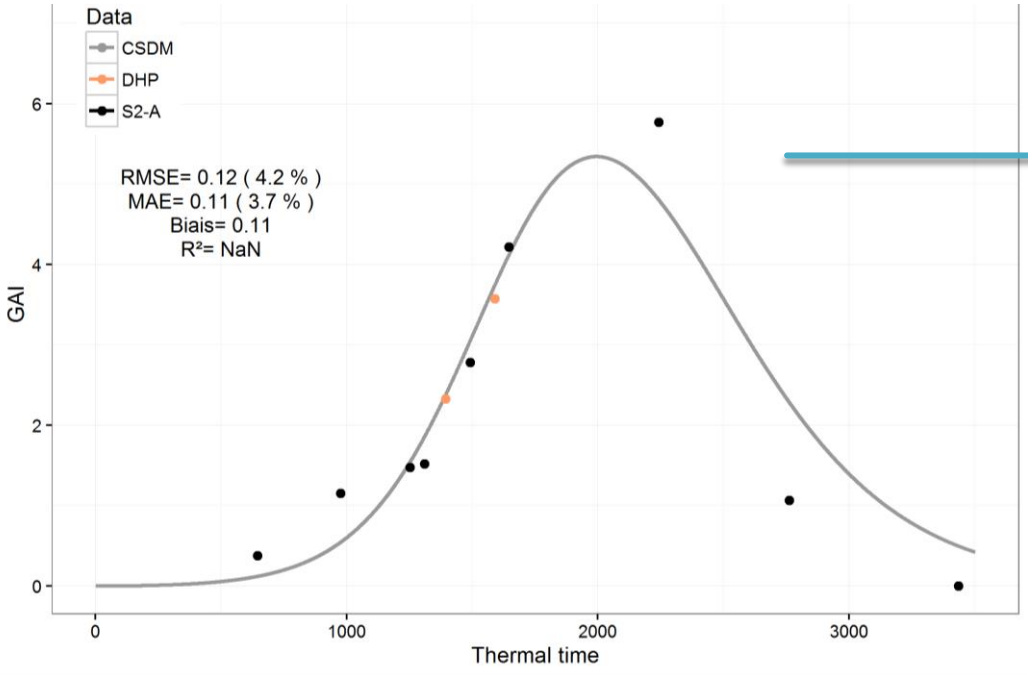
CROP DEVELOPMENT MONITORING

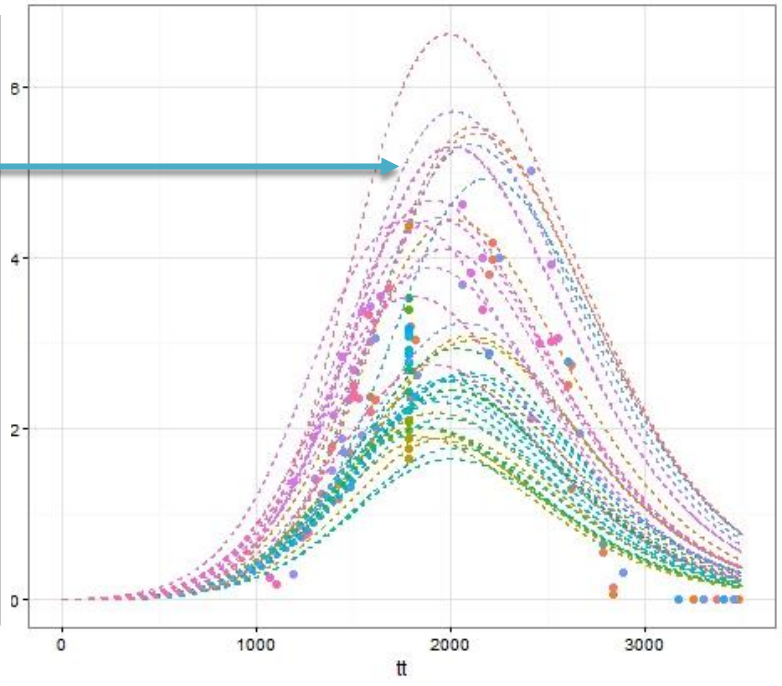
&

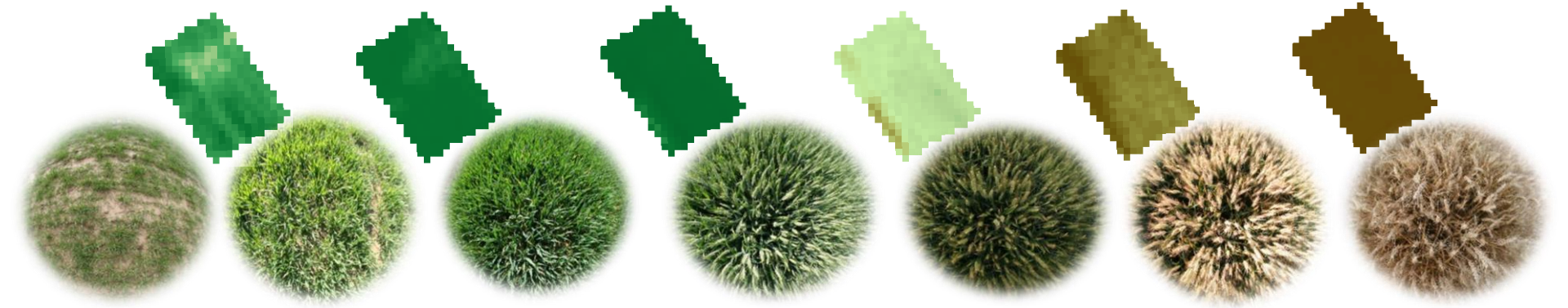
ANOMALY DETECTION

Development monitoring
Comparison between fields

- Development monitoring during the season with the Green Area Index (GAI) and meteo data



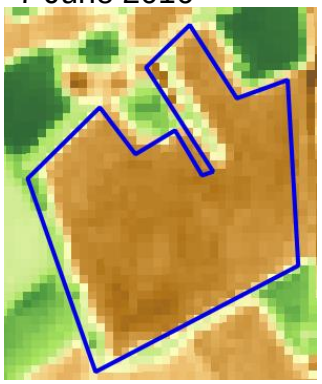




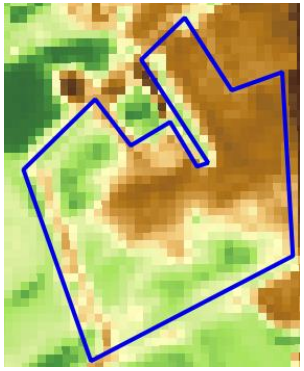
Anomaly detection

- Example on the maize (Hooibeekhoeve “Tolhuis Tongerlo”): heterogeneity due to water excess is clearly visible on Sentinel-2 fCover image time series

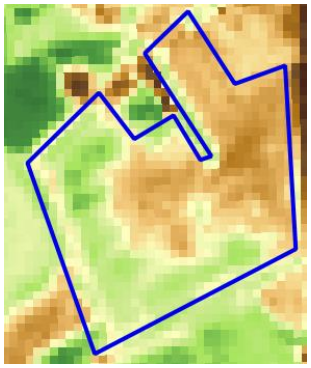
7 June 2016



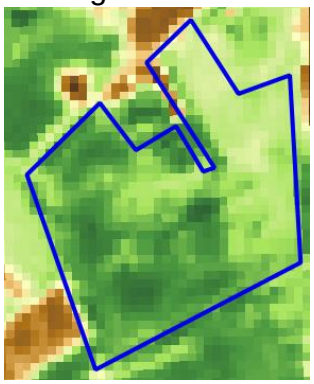
10 July 2016



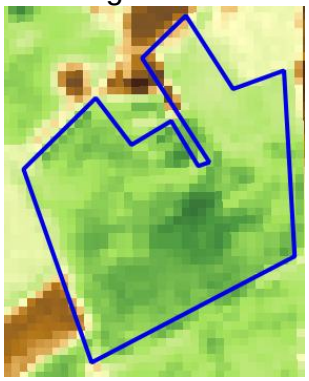
20 July 2016



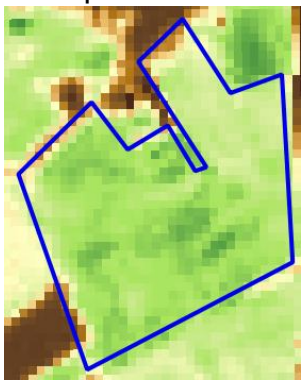
6 August 2016



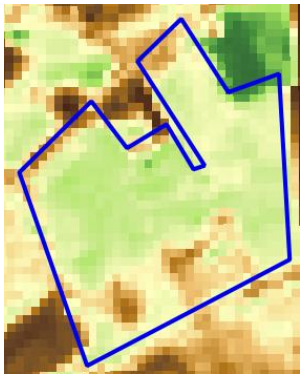
26 August 2016



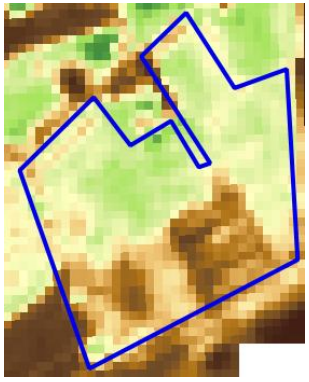
8 Sept 2016



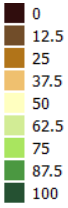
25 Sept 2016



5 Oct 2016



fCover



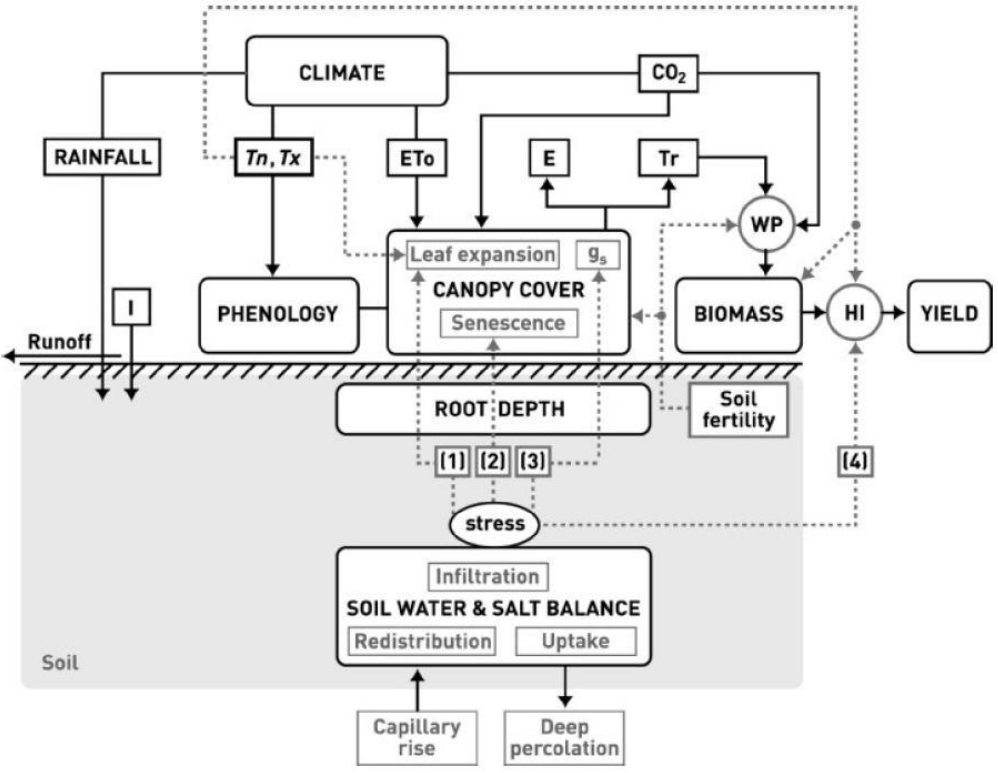
1 July 2016

First results

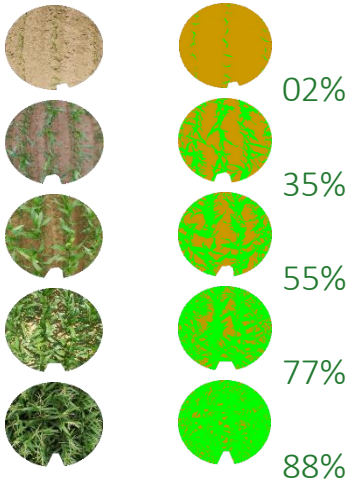
YIELD ESTIMATION

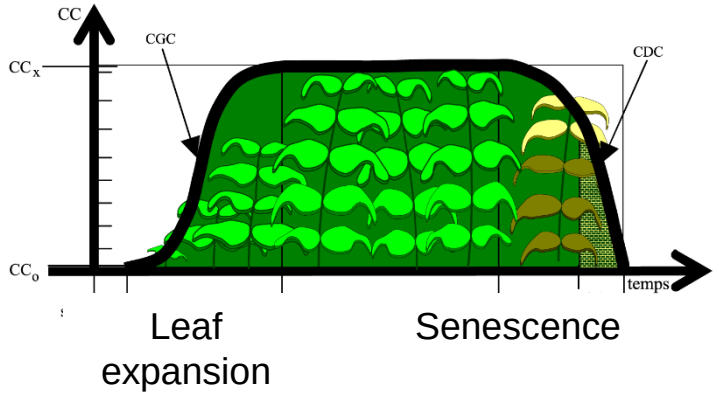
Yield estimation based on Aquacrop
Integration of fCover from Sentinel-2

- Simple and robust model to estimate the biomass and yield (Requaferti input)
- Based on several factors including meteo data and development cycle of the crop



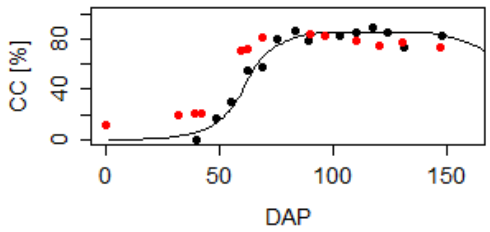
Regional follow-up of the crop with DHP

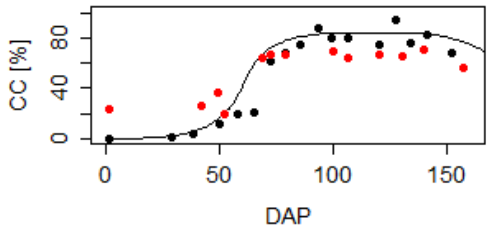


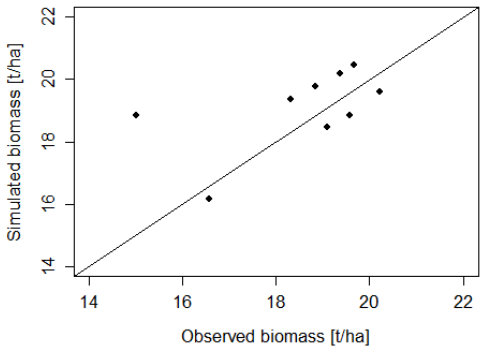


Yield estimation based on Aquacrop
First results

Maize

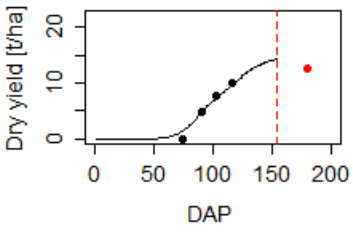


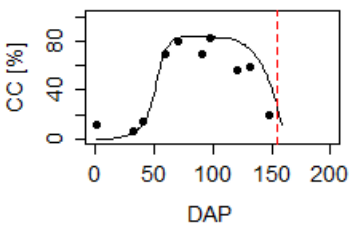


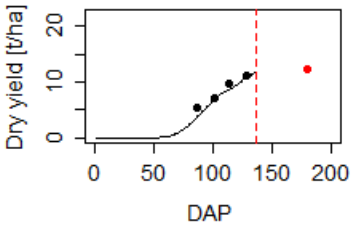


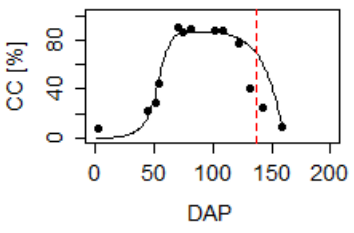
Error = 1,6 ton/ha

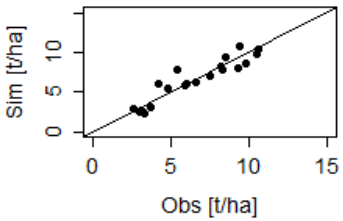
Potato

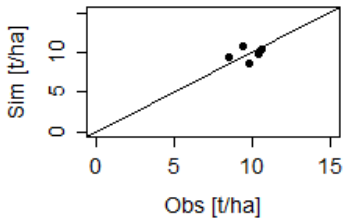






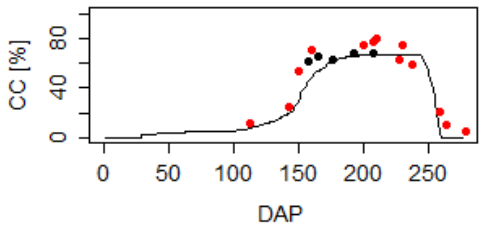


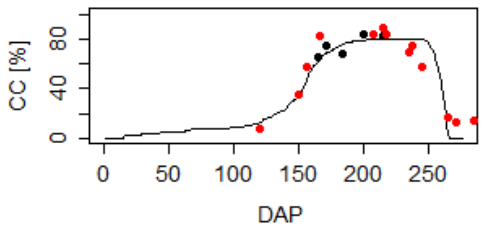


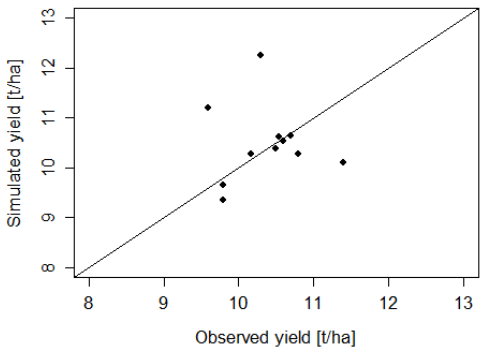


Error = 0,9 ton/ha

Winter wheat





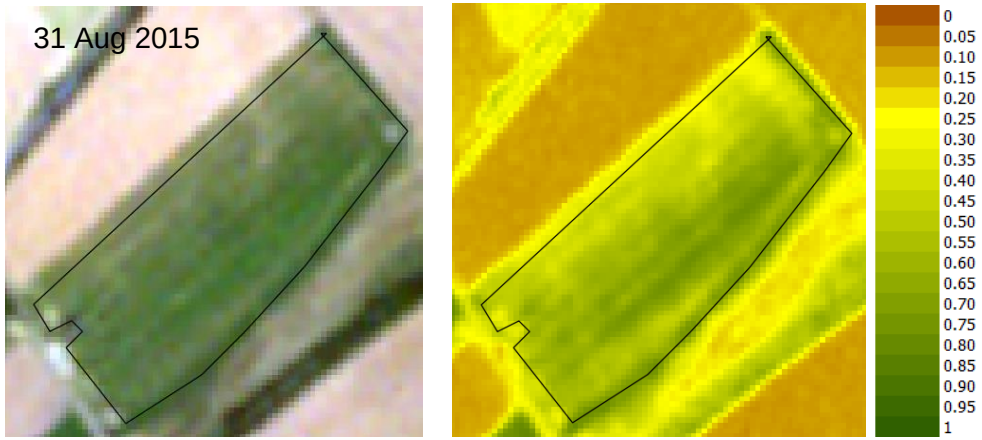


Error = 0,9 ton/ha

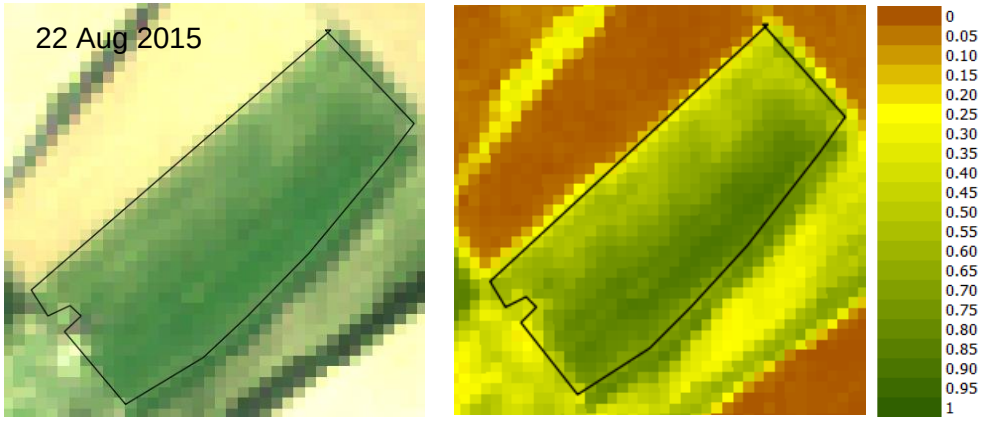
Development of products of interest requested by the partners

Product requested by the PC/TC
Intra field heterogeneity map (1)

RapidEye, 5m (visual & fAPAR)

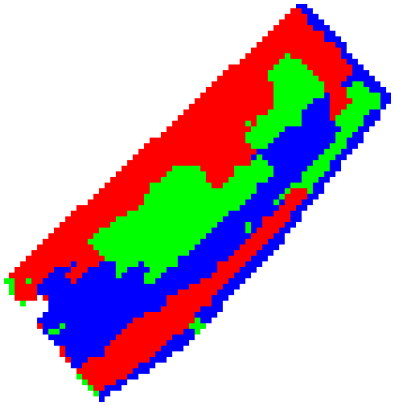


Sentinel-2, 10m (visual & fAPAR)

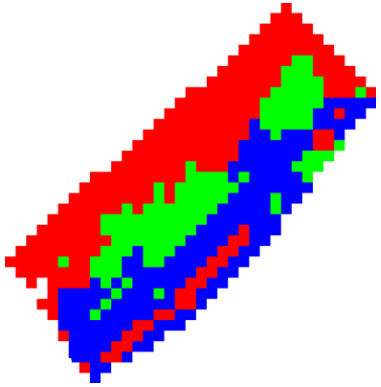


Example: potato field in Gembloux

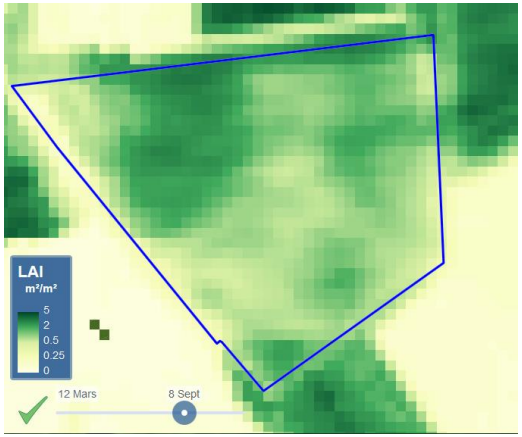
Segmentation results

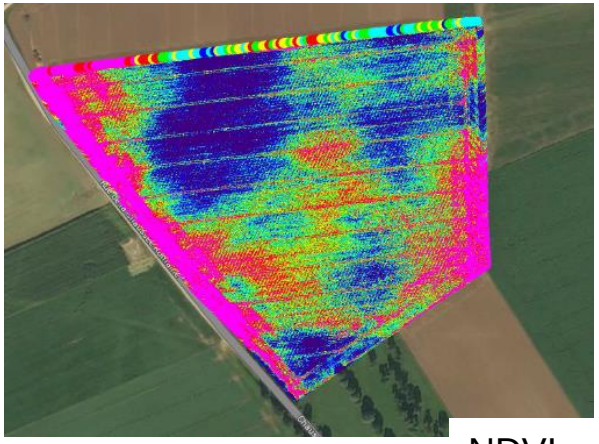


→ Similar zones



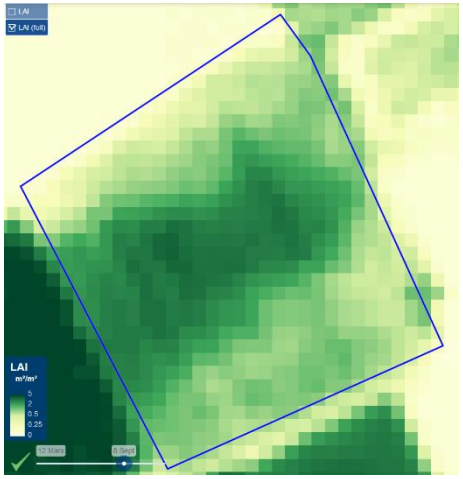
Product requested by the PC/TC
Intra field heterogeneity map (2)



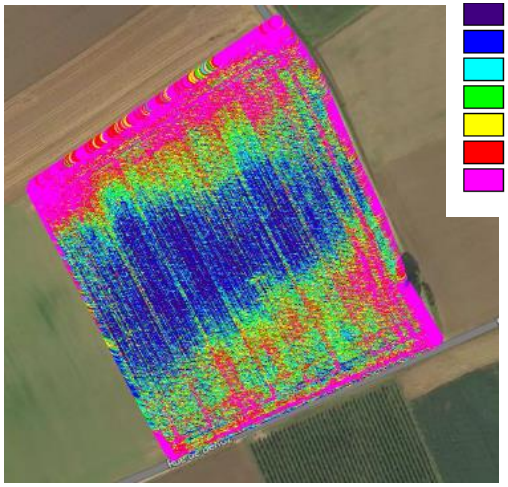


NDVI

0,854 - 0,934
0,795 - 0,853
0,735 - 0,794
0,670 - 0,734
0,596 - 0,669
0,499 - 0,595
0,173 - 0,498



08/09/2016, GAI from Sentinel-2



09/09/2016, NDVI from UAV flight - Hesbaye Frost

- Biophysical variables (fAPAR, GAI) retrieved from Sentinel-2 images show a good potential to map intra-field heterogeneity
- Research is ongoing on this product

Product requested by the PC/TC
Water damage detection

- VITO R&D results on using UAV and Sentinel-2 for water detection on a potato field managed by Jacob Van den Borne:

UAV fCover < 60% → crop lost or severely damaged

Flanders: 15% lost or severely damaged

Per province:

- *Antwerpen: 35%*
- *Limburg: 19%*
- *Vlaams-Brabant: 13%*
- *Oost-Vlaanderen: 12%*
- *West-Vlaanderen: 11%*

Flemish agricultural regions:

- *Kempen: 26%*
- *Vlaamse Zandstreek: 11%*
- *Duinen en Polders: 8%*

Adjustment of the threshold for Sentinel-2 → <50%

Thank you for your attention