Use of NIR Hyperspectral Imaging and dichotomist classification tree based on SVM in order to discriminate roots and crop residues of winter wheat.

Gembloux Agro-Bio Tech
Université de Liège

D. Eylenbosch[a], J.A. Fernández Pierna[b], V. Baeten[b], B. Bodson[a]

[a] Gembloux Agro-Bio Tech, University of Liège, Temperate Crop Science Unit, Belgium. E-mail: d.eylenbosch@ulg.ac.be
[b] Walloon Agricultural Research Centre, Valorisation of Agricultural Products Department, Food and Feed Quality Unit, Belgium.

cra-w

Context: Quantification of **roots** and **crop residues** is important to understand the impact of agricultural practices on root system development and crop residues decomposition. Current method based on hand sorting is tedious, time-consuming and depends on operator subjectivity. **NIR Hyperspectral Imaging** (NIR-HI) could be a good alternative as rapid method to sort crop residues and roots extracted from soil samples and to quantify them.

Methodology

Sampling

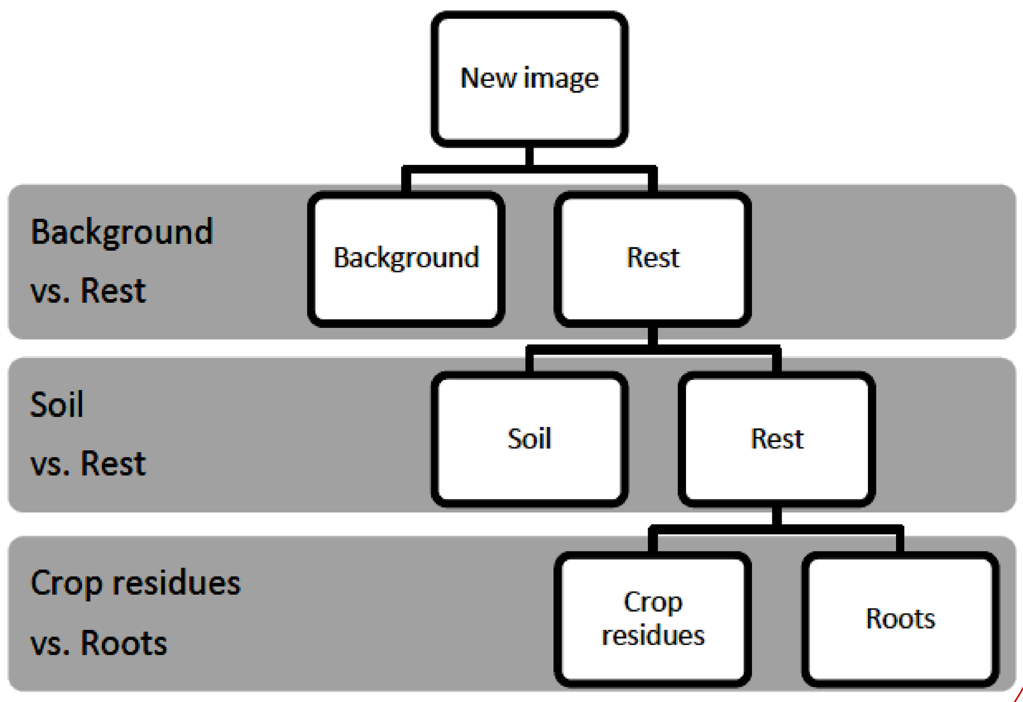
Roots and crop residues of winter wheat were collected in fields by soil coring and extracted from cores using tap water.

Image acquisition

NIR images were acquired with a **NIR hyperspectral line scan** (= push-broom) (Vermeulen et al., 2012). Samples were laid on a conveyor belt placed under the NIR camera. For each pixel of the NIR image, a complete spectrum including 209 wavelengths (1100-2498 nm) was collected.

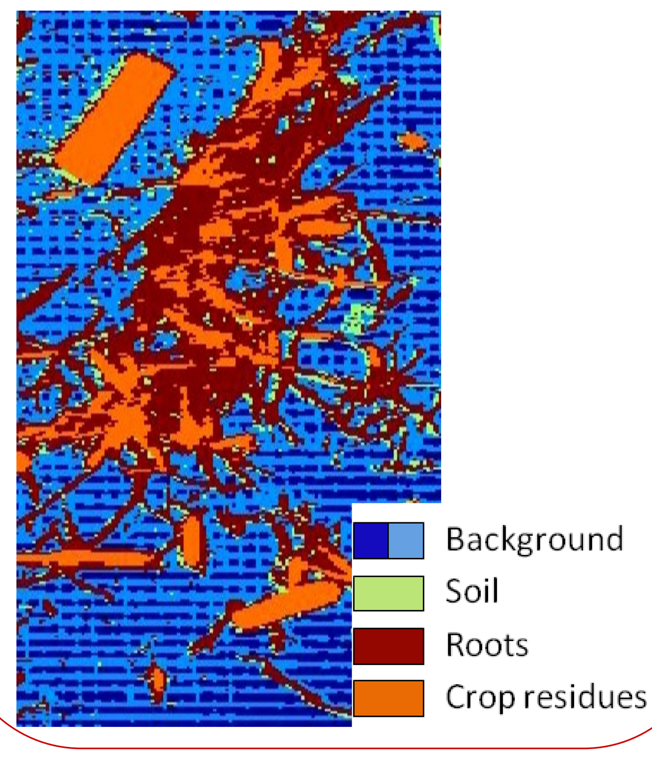
Spectra discrimination

A dichotomist classification tree based on 3 successive SVM* models was used to separate spectra into 4 distinct classes: background, soil, crop residues and roots (Eylenbosch et al., 2014; Fernandez Pierna et al., 2004).



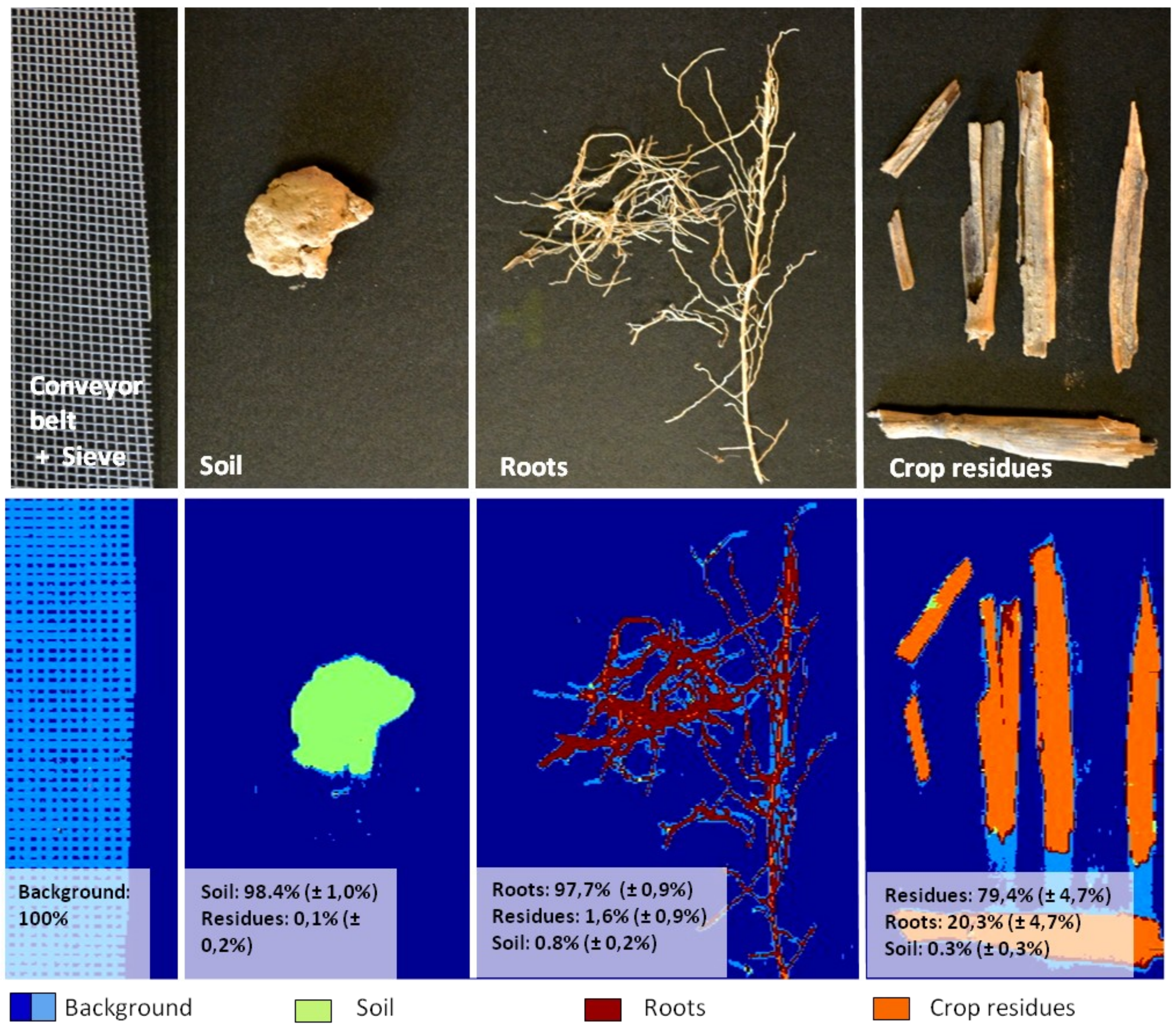
Prediction and quantification

A color was assigned to each class allowing to create a prediction image. Quantification of crop residues and roots is based on the number of pixels detected as such using the dichotomist tree.



*** SVM** : Support Vector Machine is a linear algorithm used for classification purpose (Zhang, 2010) .

Results and conclusions



Percentage of pixels (± standard deviation) predicted as belonging to each spectral class when models were applied on images of sieve (= background), soil, roots or crop residues of winter wheat.

Importance of models calibration and validation:

- **Robust models** giving good predictions are created using a large number of samples trying to cover the high variability present in this kind of samples;
- All classes of spectra must be well identified. **Shadows have also a specific spectrum**! Spectra of root shadow were combined with spectra of conveyor belt in a single spectral class (= background) in order to increase sensitivity of predictions and roots spectra were consequently better classified.

Advantages of NIR-HI in quantification of roots and crop residues:

- **Time saving** compared to hand sorting**;**
- **Good prediction of background** (100% correctly predicted pixels)**, soil particles** (98.4%) **and roots spectra** (97.7%);
- Thanks to their spectral properties, **crop residues and roots from different crops could be quantified separately** in a same sample;

Limitations:

- Some **confusions** were observed **with crop residues**: pixels on the border of crop residues were often predicted as roots and dead roots spectra were predicted as crop residues. Central area of crop residues was always well predicted. In average, 79.4 % of crop residues spectra were well predicted;
- Roots and crop residues need to be well spread on the conveyor belt in order to be quantified. Overlap decreases the number of detected pixels.

References:

Eylenbosch, D., Fernandez Pierna, J. A., Baeten, V., Bodson, B., 2014. Detection of wheat root and straw in soil by use of NIR hyperspectral imaging spectroscopy and Partial Least Square discriminant analysis, in: *proceedings of the ESA XIIIth Congress*, Debrecen, Hungary, pp. 237-238.
Fernández Pierna, J. A. , Baeten, V., Michotte Renier, A., et al., 2004. Combination of support vector machines (SVM) and near-infrared (NIR) imaging spectroscopy for the detection of meat and bone meal (MBM) in compound feeds. *J Chemometr.* 18, pp. 341-349.
Vermeulen, P., Fernández Pierna, J. A., van Egmond, H. P., et al., 2012. Online detection and quantification of ergot bodies in cereals using near infrared hyperspectral imaging. *Food Addit Contam A*, 29(2), pp. 232–240.
Zhang,,X., 2010. Support Vector Machines, in C. Sammut & G. Webb (Eds.), *Encyclopedia of Machines Learning*, Spinger, pp. 941–946.