On-line measurements in experimental fields with a diode array NIR instrument on a combine harvester

L. Tual,[a] B.Mahaut[a] and P. Michel[b]

[a]ARVALIS– Institut du végétal, Laboratoire Qualité des Céréales, 16 Rue Nicolas Fortin, 75013 – Paris, France

[b]ARVALIS – Institut du végétal, Service des Etudes Statistiques et Méthodologiques, 91720 – Boigneville, France

Introduction

ARVALIS—Institut du vegetal—manages a great number of wheat experimental fields to characterize the quality of new varieties and to evaluate the incidence of farming techniques. To do this, we take roughly 4000 samples from different parts of France and analyse their protein content yearly. The protein content is measured at the laboratory either by reference analysis or by near infrared (NIR) spectroscopy and requires a significant amount of organization with sending samples to the sites concerned with the infrared analysis and the annual validation of the infrared calibrations.

By determining the protein content in the field, logistics related to analysis would be reduced. This would also avoid sampling and increase the number of analyses.

Materials and methods

Diode array NIR instrument : Zeiss Corona 45 NIR

- 128 diodes
- 950 - 1700 nm
- spectral resolution : 6nm/diode (*interpolated every 2nm for our study*)
- external white and black reference
- piloted with Cora v1.94 software (Zeiss)

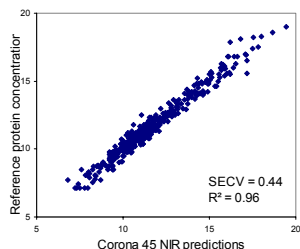PLS calibration developped with Grams v6.00 software

Figure1. Wheat protein content calibration performance

- 12 PC,
- 372 samples from 1998 to 2001 harvest scanned in flow in the laboratory
- protein range : 7.1 - 19.0 %

Validation

- during 2002 harvest, which is the first year of on-line tests
- on five trials in two different regions, representing 730 plots,
- crossing varieties with farming techniques
- 94 takings on elementary plots were carried out among the five tests in order to validate the predictions

Figure 2. Combine harvester for experimental fields

Results

Among the measurements, a significant proportion of spectra are inexploitable. The Mahalanobis distance of these scans can be very high (up to 400). Incorrect measurements always follow bad measurements of white and black standards and are encountered in any of the five trials. This illustrates the incidence of good or bad reference measurements.

Possible causes of incorrect measurements of standards :
- pre-heating time : is it as important in the field as it is in the laboratory ?
- environmental conditions during the white and black measurements ? (for example, effect of external luminosity)

Concerning the 94 validation samples, 42 were eliminated because they were measured after an incorrect reference. Of the 52 remaining samples, among the five trials, we found that in the field, under good conditions, the measurements correspond to the "laboratory" performances.
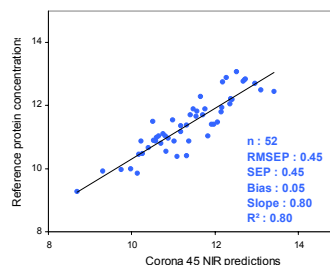

n : 52
RMSEP : 0.45
SEP : 0.45
Bias : 0.05
Slope : 0.80
R² : 0.80

Figure 3. Validation on harvest spectra

Prospects

- to improve the conditions of measurement of the white and black standard
- to set up a way to check, in the field, the correct measurement of the white and black as it is done in the laboratory
- to better the protein calibration by enriching the database with spectra obtained during the harvest
- to develop other calibrations
- **development of a partnership between Nickerson International Research, le Centre de Recherches Agronomiques de Gembloux and ARVALIS - Institut du végétal in order to progress on technical aspects and to improve robustness of calibrations by sharing our databases**.