NEAR INFRARED SPECTROSCOPY TO PREDICT LIQUID AND SOLID MANURE NUTRIENTS

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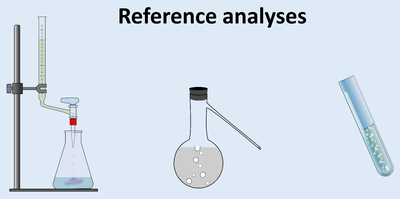
Farmyard manure enable substantial savings on chemical fertilizers and improve soil quality by adding organic matter, stimulating biological activity and improving soil structure.

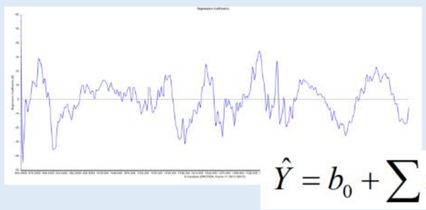
Standard laboratory analysis can be time-consuming and costly. Near infrared spectroscopy (NIRS) is an attractive alternative as it is fast, non-destructive, reproducible and cost-effective. However, to develop robust and accurate predictive models, precise reference and spectral data are required.

Reference analyses



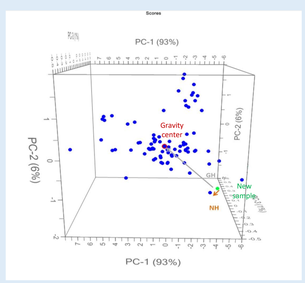
NIRS

PLS Calibration



$$\hat{Y} = b_0 + \sum b_i x_i$$

Prediction validation

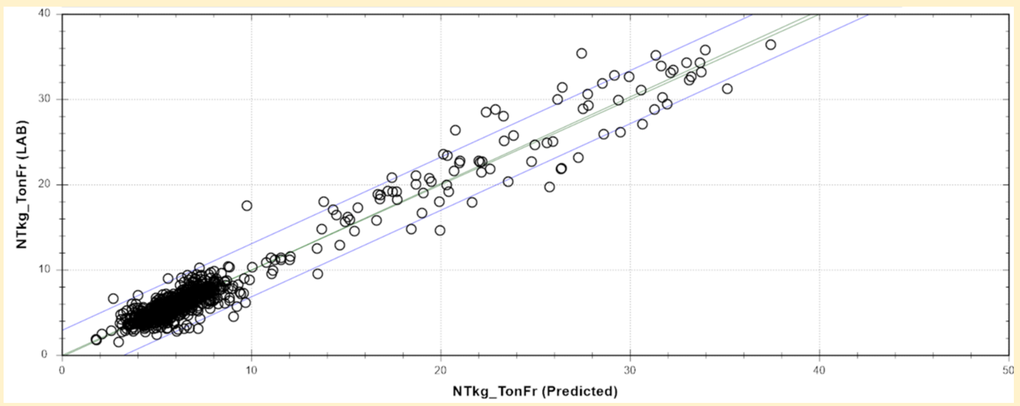


- REQUASUD (laboratory network in Wallonia, Belgium) has build a database for liquid and solid manure, containing reference analyses of more than 2900 homogenized samples for pH, dry matter (DM), organic matter (OM), total nitrogen (Nt), ammonium (NH_4^+) and phosphorus (P), potassium (K), sodium (Na), magnesium (Mg), calcium (Ca) and sulfur (S) expressed in their oxide form.
- Reference values are associated with spectra measured on fresh homogenized samples with a FOSS XDS *(FOSS NIRSystems Inc., Denmark)*, operating in the 400-2500 nm wavelength range, with 2.0 nm spectral resolution.
- Performance of the predictive PLS model was evaluated according to : The root mean square error of cross-validation (SECV), the standard error of calibration (SEC), the standard deviation (SD), the determination coefficient (R^2 value) and the ratio of prediction to determination = SD/SEC (RPD). RPD criterion takes into account the variability of the database. It is a useful indicator to compare results obtained using diverse databases, or results in the literature.
- A good predictive model = R^2 close to 1; SEC as small as possible and close to the reproducibility of the reference method (determined by proficiency tests); and RPD > 2 or 3 depending on the matrix and the authors.
- Predicted results are validated using two mathematical measures: the GH (Global H or Mahalanobis Distance) and the NH (Neighbor Distance). A satisfactory level of confidence is achieved when GH values are < 3 and NH values are < 1.

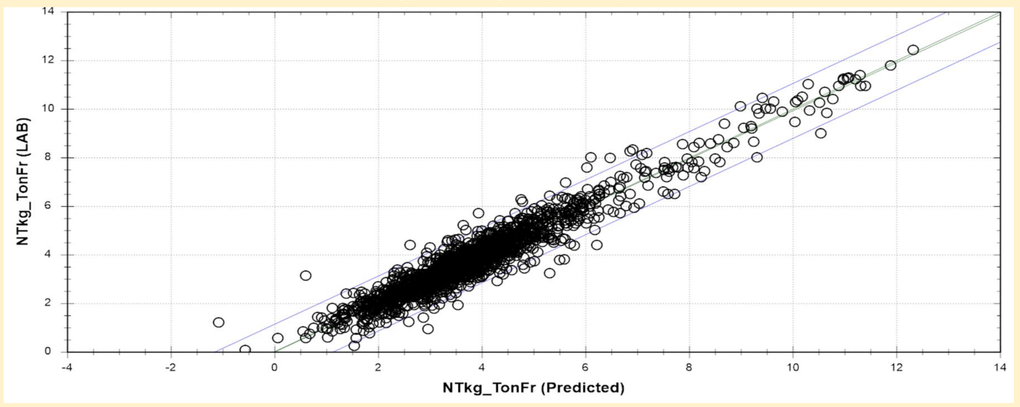
The most remarkable results concern the RPDs obtained for DM, OM, Nt, NH_4 (all > 3 for liquid and solid manure) and P_2O_5 (> 3 only for solid manure). Results also show very interesting coefficients of determination, particularly for solid manure.

Accepted performance of predictive models for routine use in Walloon laboratories of NIR predictions on liquid and solid manure (without the visible spectral range - 1100-2498 nm). N is the number of reference data available.

	LIQUID MANURE					SOLID MANURE				
	N	SEC	SD	R^2	RPD	N	SEC	SD	R^2	RPD
DM	1807	0.69	2.28	0.79	**3.30**	1029	2.02	10.11	0.96	**5.00**
OM	728	0.63	2.05	0.48	**3.25**	879	1.36	7.31	0.93	**5.38**
Nt	1760	0.43	1.61	0.78	**3.74**	923	1.21	5.89	0.95	**4.87**
NH_4	1427	0.27	0.9	0.72	**3.33**	432	0.52	1.89	0.96	**3.59**
P_2O_5	1704	0.37	0.73	0.55	1.97	901	0.84	3.62	0.90	**4.32**



NIRS prediction vs Laboratory reference values for nitrogen content of solid (up) and liquid (down) manures



This study demonstrates the ability of NIRS to accurately determine DM, OM, Nt, NH_4 content in farmyard manures, as well as P_2O_5 (only in solid manures at the moment). These parameters are currently being predicted by NIRS as part of routine operations in the reference laboratory of the REQUASUD network, located at the UCLouvain - Centre de Michamps.

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Avec le soutien de la Wallonie