

Near Infrared Spectroscopy (NIRS): what it is and how it works



NIRS analysis: what is it?

- It is a spectroscopic techniques that allows rapid prediction of chemical composition and biological properties (e.g. digestibility) of feed and forages;

Two minutes

One day

Analysis

1. Moisture
2. Protein
3. Fat
4. Fiber

The electromagnetic spectrum

The Visible Spectrum

The NIR region is close to the visible region.

Protein, sugar, fiber, fat and moisture absorb light at different wavelengths in the NIR region. Based on the absorption of light in the NIR region we can predict the composition of forages.

History of NIR spectroscopy

1800	The First NIR Spectrum recorded (Herschel)
1950-1960	Potential of NIR quantitative analysis was recognized (Kaye)
1960s	Research program at USDA (Norris) for NIR analysis of agricultural commodities
1971	First Generation of NIR Instruments - Reflectance
1975	Second Generation of NIR Instruments - More Stable Electronics and improved Optics
1977-1978	Third Generation of NIR Instruments - Microprocessors, Small Computers
1982-1983	Fourth Generation of NIR Instruments - Scanning Monochromators
1980s	New calibration techniques introduced
1987	Fifth Generation of NIR Instruments - Transmittance
1994	Nonlinear calibration methods (ANN)



Near Infrared Reflectance Spectroscopy

- USDA-ARS established national research network
- Norris et al. 1976
- Shenk et al. 1978
- Marten et al. 1989

Commercial Forage Testing Industry

- before 1970 - protein, crude fiber, and minerals
- during 1970's introduction of detergent fiber system
- 1976 Norris et al. USDA-ARS introduced Near Infrared Reflectance Spectroscopy (NIRS)

How it works?

First we compute a calibration, an equation that relates NIR spectra to laboratory values

Use of a Calibration

Then we use the calibration equation to predict the composition of forage samples based on their spectra

How to create a calibration

The calibration must perform on any possible sample. Therefore, we select sample to include all possible source of variation that we expect for each product

Reference Analysis

NIRS is a secondary method based on regression using a primary method (reference data). A NIRS prediction can NEVER be more accurate than a reference analysis.

Applications

- Agriculture
- Chemical Ind.
- Food Ind.
- Polymers
- Textile
- Biotechnology
- Cosmetics
- Medicine
- Pharmaceutical
- Paper Ind.

What the future of NIRS in agriculture?

NIRS predictions are largely used in forage commercial lab

In the future miniaturized NIR instrument could be used directly by farmers to improve efficiency of production, reduce environmental impact of agricultural activities and to improve quality of products.