MAIZE FOR SILAGE QUALITY DETERMINATE BY CLASSICAL AND NIRS METHOD

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Abstract

The quality of maize silage is strongly influenced by the choice of harvesting time and for organizational measures in the process of harvesting and conservation. Protein is the only substance that contains nitrogen (N). By crude fiber it is understood the organic rest from the organic acid hydrolysis of the feed sample. Van Soest developed a method for a better differentiation of cell wall components. By NDF it is understood that part of the cell wall consisting of hemicellulose, cellulose and lignin. ADF content is regularly higher than the crude fiber in feed, ADF and crude fiber content being closely correlated. Lignin is a component of cell wall carbohydrate that can't be digested, not even with the help of the body's own enzymes or of the microbial enzymes. The objective of the study is general characterization of feed quality determined by classical and NIRS methods.

INTRODUCTION

Forage quality is strongly influenced by the harvest time, so optimal harvest time is not only determined by the age or by the highest mass production time but by the maximum digestible nutrients per unit area and per season (including several harvests (cuts, grazing,...) in one season. This time differs from one forage to another, depending notably on the species or floristic composition in meadows (Rotar et al., 2005).

The quality of maize silage is strongly influenced by the choice of harvesting

time and for organizational measures in the process of harvesting and conservation. For many, amongst which Veron (1992), nutritional value should become the first criteria in choosing silage hybrids for culture, even before production potential, and Barriere et al., (1997), appreciates that tomorrow's maize silage crop should be one with a nutritional value adequate for ruminants.

Components of forages are water and dry matter, the latter including minerals and organic substances that consists of three main categories of substances, namely proteins, lipids and sugars. Forages for ruminants (herbivors) mainly derive from plant and have two types of structures: cell wall and intracellular constituents (Jarrige et al., 1988).

Proteins are macromolecular links, whose monomers are amino acids in whose composition there can be found mainly 20 amino acids. Protein is the only substance that contains nitrogen (N). Laboratory analyses it is determined the content of N, not the amount of the protein. Proteins represent 16% of N. By multiplying the element contents of N with 100/16 = 6.25 is determined protein content. Some substances in foods have an N content, like proteins. These substances are called amides. It can be seen as a transition phase between N taken from food and protein. Thus we speak of protein but not crude protein: protein + amide (Burnea, et al, 1977).

Cellulose is, according to Jarrige et al., (1988), a glucose poliozid with a partial crystalline structure. By crude fiber it is understood the organic rest from the organic acid hydrolysis of the feed sample. Besides the cell wall polysaccharides, crude fiber contains other substances of the cell wall (Carlier et al., 1998). Crude fiber was determined by WEENDE destructive method, and the calibration model for crude fiber content was built in order to validate the method.

NDF or cell wall is the fiber feed and is composed of structural carbohydrates (cellulose and hemicelluloses), lignin, other phenols, cutin, and silica (Moore and Hatfield, 1994).

By NDF it is understood that part of the cell wall consisting of hemicellulose, cellulose and lignin (Carlier et al., 1998). Van Soest developed a method in 1960 for a better differenciation of cell wall components (Jeroch et al., 2008). Collins and Fritz, in 2003 indicated that the method developed by Van Soest is one of the most used analyses of feed and it is the only method which allows the distinction between cell walls and cell contents.

Van Soest developed a method for a better differentiation of cell wall components (Jeroch et al., 2008). The amount of protective substances residue obtained after boiling the feed sample with acid detergent solution is called ADF. By ADF it is understood that part of the cell wall made of cellulose and lignin (Carlier et al., 1998). ADF content is regularly higher than the crude fiber in feed, ADF and crude fiber content being closely correlated.

Lignin is a component of cell wall carbohydrate that can't be digested, not even with the help of the body's own enzymes or of the microbial enzymes, Jarrige et al., (1988). Lignin dosage highlights the fact that it is the most important impediment in the microbial digestion process, preventing the digestion of carbohydrates in cell walls. Lignin has complicated structure and composition, due to the lignified cells (Carlier et al., 1998). For lignin the term armor is also used. Jeroch et al., (2008) said that he can distinguish cell wall components in a better way. Lignin is closely related to various polysaccharides such as complex lignino-cellulose. This is not only an indigerable component but also an antimicrobial barrier for forage plant cell. In the analysis scheme of Van Soest, lignin is the residue obtained

consecutively by the destruction of 72% sulfuric acid of ADF (Jarrige et al., 1988).

METHOD AND MATERIAL

Compared crops of early maize hybrids (FAO 250-320) and medium early hybrids (FAO 340-450) were located in 2005 in the experimental field of the Breeding Laboratory of in ARDS Turda (after Ceclan, 2010). In this study it was taken into consideration from 2006 and 2007. Sampling was performed during the wax beans. Although the experiment was the quality of maize for silage bifactorial determination was made on samples of all hybrids average as follows: maize stalk+leaves and maize ear.

To determine the quality of the feed, samples were collected of 100 g, they were homogenized and analyzed with the help of destructive method for crude protein, crude fiber, NDF, ADF, lignin in the laboratory within the Department of Grassland and Forage Crops, University of Agriculture Science and Veterinary Medicine Cluj and Department of Animal Science Unit, GxABT, University of Liège.

Forty-three samples of maize stalks+leaves and maize ear were determined by classical method. For nondestructive methods was used determination of the chemical composition of forage with the help of infrared spectrometry (NIRS).

NIRS steps are:

1. Classical analysis determination;
2. Database collection;
3. Spectra samples collecting;
4. Samples selection for calibration set;
5. Dates registred and building the mathematical model.

REZULTS AND DISCUTIONS

The use of NIRS technology in recent years has become the most commonly method used to determine physical and chemical properties of feed. This technique is elegant and very precise technique, Figure 1. Typical spectra have shown a typical spectrum with maize stalk+leaves and maize ear typical spectrum.

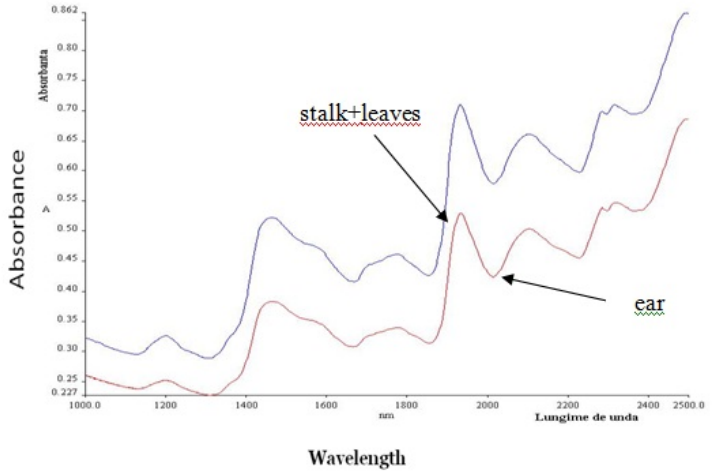

Figure 1. Typical NIRS spectrum for maize: stalk+leaves and ear

It is intended to a way to direct analysis method of crude protein content, crude fiber (cellulose) content, NDF, ADF, ADL content using the nondestructive near infrared spectroscopy in attenuated total reflectance coupled with technique. So, after each sample was collected using Perkin Elmer Spectrum One Spectrophotometer with NIRA accessory, in Laboratory of Grassland and Forage Crops, and FOSS Spectrophotometer 6500, the CRA-W, the samples were determined with the help of destructive method. For calibration there was used the mathematical calculation using Quant program Spectrum + v4.60, and was being used WIN ISI.

In table 1. crude protein content, crude fiber (cellulose) content, NDF, ADF, ADL content are presented as determined by the classical method of maize for silage.

Table 1.

Chemical composition (DM %) determinated by classical methods

Samples	CP	CF	NDF	ADF	ADL
Maize stalk+leaves 2006	6.28- 7.97	38.94-42.23	72.48-76.51	45.51-50.34	6.14- 8.31
Maize stalk+leaves 2007	3.79- 4.16	40.11-46.46	73.62-79.66	46.94-56.22	6.06- 9.84
Maize ear 2006	3.37- 5.83	6.93 - 12.79	18.11-32.14	2.95 -16.26	0.56- 2.96
Maize ear 2007	2.51- 3.15	6.93 - 12.94	18.11-35.43	2.48 -16.81	0.51- 4.13

After the crude protein content, crude fiber (cellulose) content, NDF, ADF, ADL content was determined with the help of destructive method, each sample was collected using Perkin Elmer Spectrum One Spectrophotometer with NIRA accessory in laboratory of Grasslands and Forage Crops. Spectra were recorded by filling in a standard test sample and scanned in an intercalate mode and built mathematical model for maize for silage, which is based on multivariate analysis techniques to determine a best prediction error for crude protein content, crude fiber (cellulose) content, NDF, ADF, ADL content. Using these values for the spectra it was built a mathematical model for direct determination of these chemical properties.

For the content of crude protein content, crude fiber (cellulose) content, NDF, ADF, ADL content from the samples of maize stalk+leaves is necessary to build a mathematical model and another mathematical model for crude protein content, crude fiber (cellulose) content, NDF, ADF, ADL content of maize ear samples, as it is are two different parts of a plant. In order to obtain that the samples were scanned in two repetitions, data were collected between 1100-2500nm 2nm 2nm, interlace

mode, namely randomized using FOSS Spectrophotometer Silver Spring MD 6500, USA. The models were built in the ISI program - Monitor V.1.50.e based algorithm PLS (Partial Least Square Regression) using MPLS (Modified PLS) using pre-processing technique: Smouth 1, 5 points, the first derivative, 5 points and cross - validation. Figure 2. and Figure 3., presents the external validation of calibration models on abscissa where the reference value is written, and on coordinated, the analytical value of property determined. Cozzolino et al., (2000) recounts in his article that there are correlations between the reference data, between crude protein content and data obtained by NIRS technique, and shows that there are differences between the protein content of maize ear and of the maize stalk+leaves.

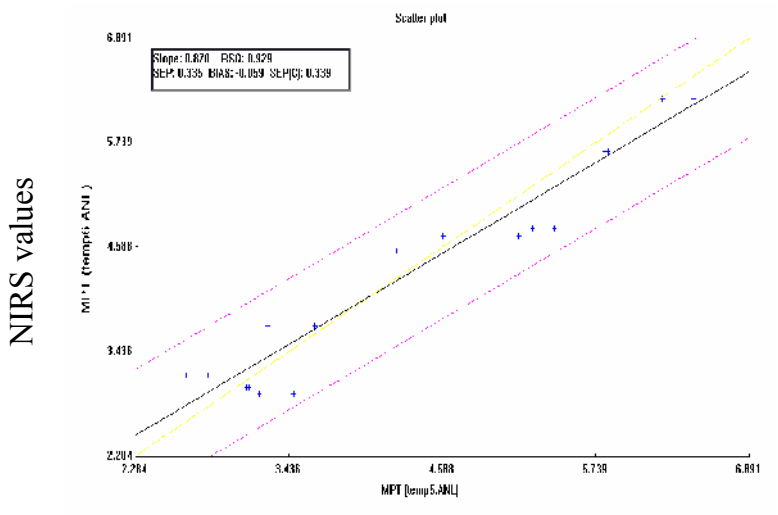

Figure 2. Crude protein – External validation of calibration model (maize stalk+leaves)

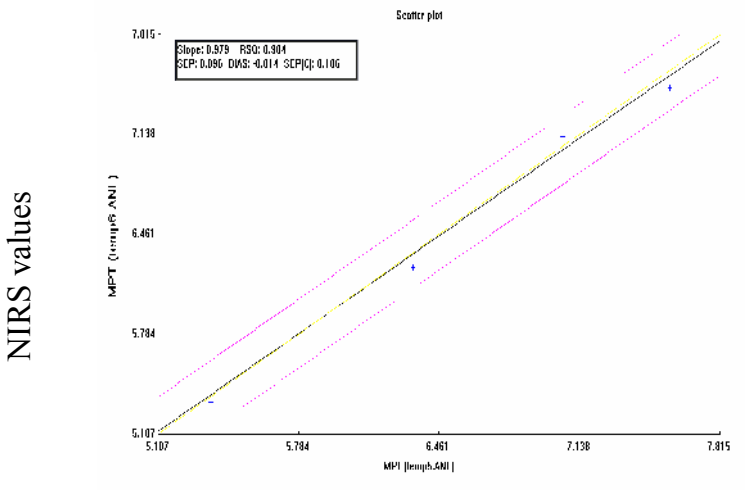

Figure 3. Crude protein – External validation of calibration model (maize ear)

Cone et al., (2008) states that the more maize advances in maturity, the crude protein content decreases. Figure 4. and Figure 5. presents the external validation of calibration models on abscissa where the reference value is written, and on coordinated, the analytical value of property determined.

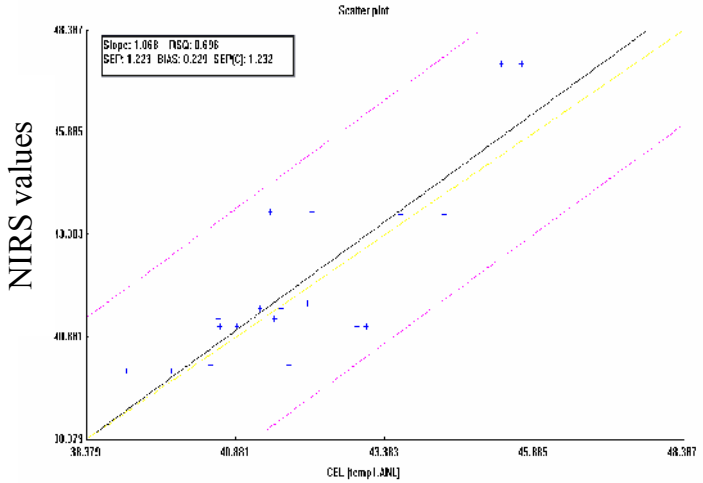

Figure 4. Crude fiber – External validation of calibration model (maize stalk+leaves)

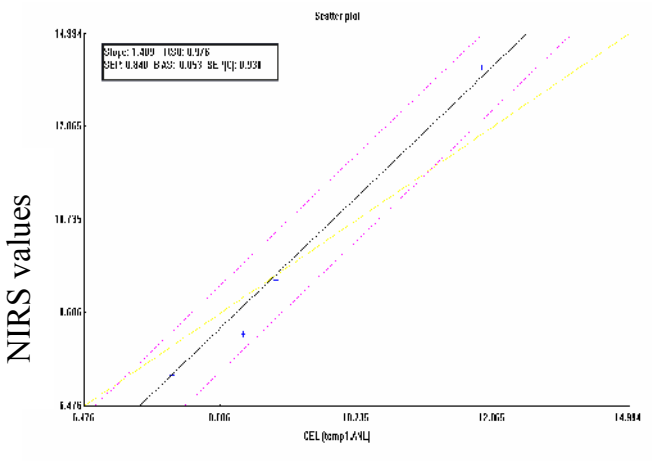

Figure 5. Crude fiber- External validation of calibration model (maize ear)

Masoero et al., (2011) reports that cellulose content is closely related to hybrid maize and is indirectly proportional to the content of crude protein and digestibility. Mierliţă (2008) states that a high content of crude fiber leads to a decrease of the organic matter digestibility Figure 6. and Figure 7., presents the external validation of calibration models on abscissa where the reference value is written, and on coordinated, the analytical value of property determined.

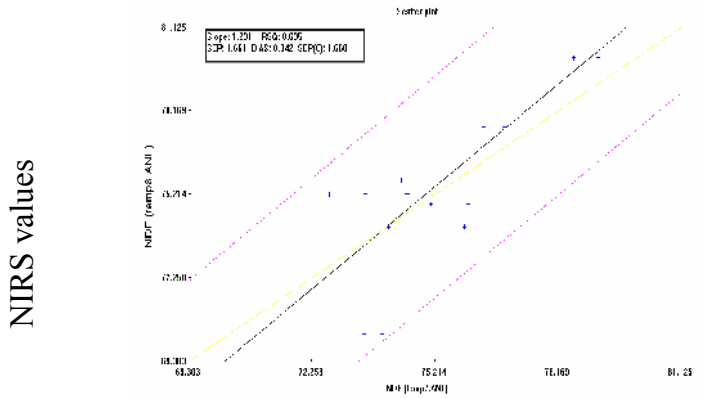

Figure 6. NDF – External validation of calibration model (maize stalk+leaves)

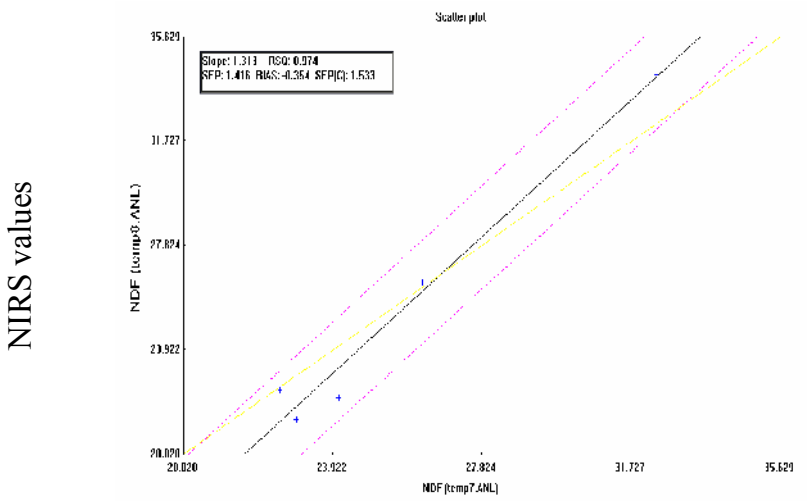

Figure 7. NDF – External validation of calibration model (maize ear)

NDF content was determined with the VAN SOEST destructive method, the results being used to build the calibration model for NDF content. NDF content varies from 10% in maize to about 80% feed on natural grasslands (Collins and Fritz, 2003). Jeroch et al., (2008) stated that maize has considerable quantities of cell walls (NDF) to ear formation. Tovar-Gomez et al., (1997) shows that the content of cell walls is influenced by the genotype hybrid maize and because of lignin content decreases. Coyolino et al., (2000) determined using the NIRS technique a very good correlation between crude ash content and content in cell walls. In figure 8. and figure 9., presents the external validation of calibration models on abscissa where the reference value is written, and on coordinated, the analytical value of property determined. ADF content was determined with the Van Soest destructive method, and after the calibration model was builds.

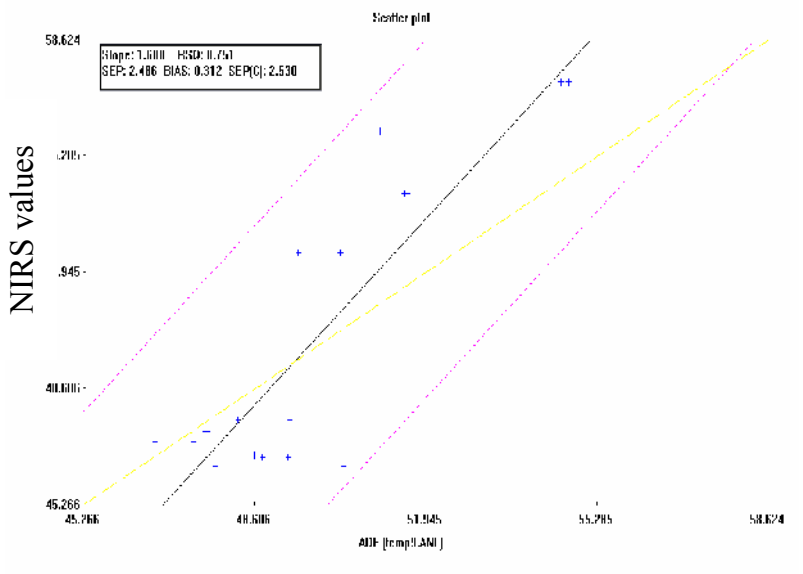

Figure 8. ADF – External validation of calibration model (maize stalk+leaves)

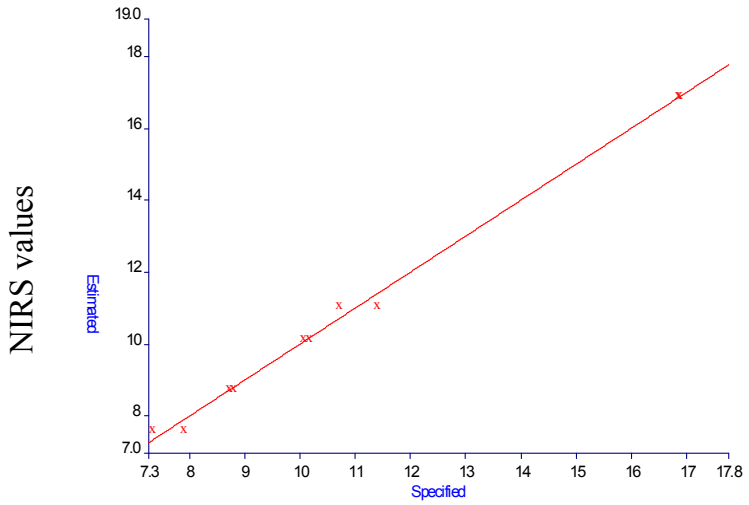

Figure 9. ADF – External validation of calibration model (maize ear)

Phipps and Weller (1979) show that the lower the grain production is, the more decreased the concentration of ADF in maize ear is. Cozzolino et al., (2000) determined with the help of

NIRS technique a very good correlation between ADF content and crude ash content, but also between ADF content and content in cell walls.

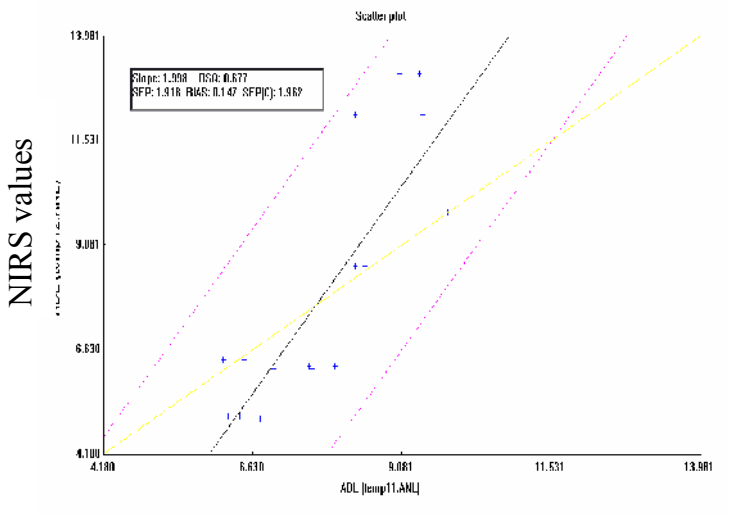

Figure 10: ADL – External validation of calibration model (maize stalk+leaves)

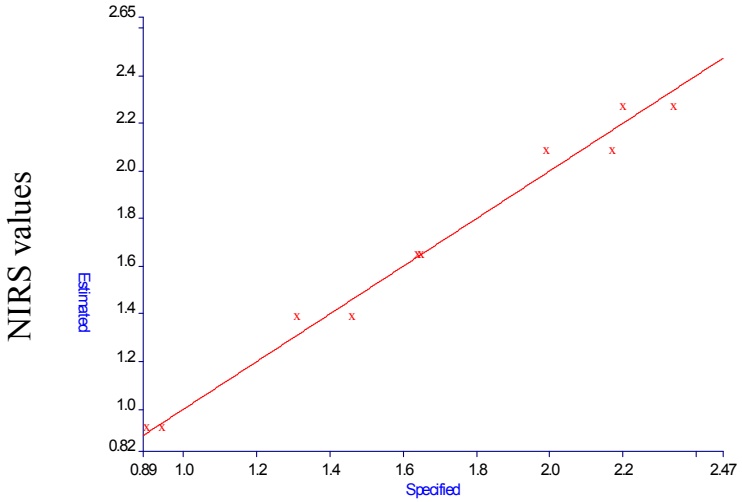

Figure 11. ADL – External validation of calibration model (maize ear)

Figure 10. and Figure 11., presents the external validation of calibration models on abscissa where the reference value is written, and

on coordinated, the analytical value of property determined.
The construction of an equation containing both ADF content (which is composed of cellulose and lignin) and ADL content (lignin) is much better understood than the construction of simple equations for each property, because these two properties are interrelated (De Boever et al., 1997). Carlier et al., in 1998 shows that, due to the mutant known under the name of „brown midrib", at maize, the content in lignin is higher and so the digestibility of the maize is improved. Dardanne et al., (1993) shows the fact that the content in lignin (ADL) is the best predictor of the organic matter digestibility.

CONCLUZIONS

The system of analysis using NIRS can be successfully applied to determine the hay's quality and the crude protein, crude fiber, NDF, ADF and lignin content. The use of the near infrared analysis technique supposes an extremely precise and uniform methodological preparation, starting with the harvest, packaging, preparing and storing the samples destined to be analyzed. Near infrared spectroscopy (NIRS) can be used in all laboratory analysis of forages. NIRS has established itself in agricultural analysis over decades and can be focus in both theoretical and practical ongoing development work. It will continue to gain significance this tehnique, NIRS method, if is assumed the transition from the laboratory to field measurements and thence to online measurements performed directly on the harvester.

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