The use of near infrared reflectance spectroscopy (NIRS) to follow the leaf/stem ratio of legumes during drying

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Introduction Legume-rich mixed swards allow the production of a high quantity protein-rich forage with low nitrogen input. Nevertheless, during hay or silage making, dry matter losses as high as, 40 and 25 % have been recorded (Ciotti & Cavallero, 1979; Stilmant *et al*., 2004). These losses have mainly been linked to the high sensitivity to physical loss of legume leaves during drying. The development of a tool to characterise leaf losses or leaf/stem ratio during drying will help us to define the technical approach to reach the best compromise between quality loss reduction and good pre-wilting of legum-rich mixed swards. The aim of the present work was to test the potentialities of near infrared reflectance spectroscopy (NIRS) to quantify legume leaf/stem ratio in mixed grass-legume swards. The mixtures tested were perennial ryegrass-white clover (PR-WC), perennial ryegrass-red clover (PR-RC), timothy-red clover (T-RC) and cocksfoot-lucerne (C-L) swards. This technique has been successfully used to quantify leaf/stem ratio in pure perennial ryegrass swards (Leconte *et al.* 1999).

Materials and methods Material used in this study came from 64 sward samples harvested at two stages of development (flowering and vegetative stages) on the mixed swards listed above. These swards were also used to study drying losses (Stilmant *et al*., 2004). The samples were sorted, by hand separation, into four fractions : grass, legume leaf, legume stem and rest (dead material, weeds, …). With these different fractions, 883 samples were created : 140 to 270 samples per grass-legume association. Legume stem varied between 18 and 95 %, legume leaf varied between 0 and 50 % while grass and rest materials were in the 0 to 50 % range. All samples were submitted to NIRS analysis (NIRS system monochromator 5000). Spectral data, in the range of 1100 – 2500 nm by 2 nm steps were correlated to legume leaf or stem, grass and rest fractions. Calibrations were developed according to the Partial Least Square procedure with cross validation of the ISI software.

Results and Conclusions With R^2 always higher than 0.95 and SD/SECV ratio higher than 4 (Williams, 2004), the performances of the different calibrations (Table 1) allow their use to quantify the evolution of the different fractions of a grass-legume mixture during drying as illustrated, for legume leaf fraction in Figure 1 (modified from Stilmant *et al*., 2004). According to these results, NIRS appears a promising tool to define the best management rules to follow during the drying of legume-rich mixed swards.

Table 1 Calibration performances for the different swards fractions (SD : Standard Deviation, SECV : Standard Error in Cross Validation)

	N	Mean	SD	R^2	SECV	SD/SECV
Legume leaf	868	20.2	12.77	0.98	2.24	5.7
Legume stem	869	50.9	15.93	0.97	2.80	5.7
Grass	869	15.7	12.30	0.97	2.25	5.5
Rest	872	12.7	8.49	0.96	1.96	4.3

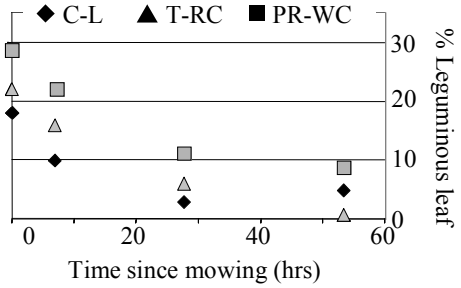

Figure 1 Leaf ratio evolution of legumes during hay making (Stilmant *et al.* 2004)

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