PASTURES FROM SPACE – ASSESSING FORAGE QUALITY USING REMOTE SENSING

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Assessing the quality of standing crops and pastures in an ongoing basis is very important for effective and efficient management of farming practices, leading to increased productivity. This work builds on the use of remote sensing technology for measuring feed-on-offer (Edirisinghe *et al*. 2004) and pasture growth rate (Donald *et al*. 2004), to estimate the nutrient content of pastures and crops using a hyperspectral remote sensing technique. Hyperspectral imagery provides surface reflectance data in the spectral range of visible to short wave infrared (400-2500 nm) and usually has more than 100 high spectral resolution channels in that range. This paper presents preliminary results of analysis of pasture samples collected at 2 locations on 3 occasions during the 2000 growing season to represent early winter growth, spring flush and senesced or mature tissue.

As the first step in using remotely sensed hyperspectral imagery to estimate forage quality characteristics, a spatially defined field spectroscopic study was conducted. Two sites located in south-west Western Australia were used for data collection. Thirty five plant species representing a diverse range of pastures and crops were sampled on spatial terms. The pasture/crop sampling strategy was to create a spatially defined target sample for analysis from taking the average of 5 neighbouring quadrates of 30-50 cm^2. Concurrently, hyperspectral reflectance measurements of corresponding pasture/crop samples were taken in the field using a GER3700 spectrometer. Freshly collected pasture samples were snap-frozen *in situ* in liquid nitrogen, freeze-dried, ground, and analysed for nitrogen content (N) and *in vitro* DM digestibility (IVDMD). The N content and IVDMD were estimated using a new field spectroscopic method and the traditional wet chemistry method in order to compare the estimated N and IVDMD values of the 2 methods. The wet chemistry method is the reference method, and used as the standard for comparison. A spatially defined and chemically derived sub-sample set of N and IVDMD concentrations representing different location/time combinations, as given in the columns of Table 1, were initially used to calibrate corresponding field spectroscopic reflectance data using a multi-linear regression model. The calibration data were then used to invert the model to predict N and IVDMD contents from known field reflectance data for validation (Table 1).

Table 1. The r^2 for laboratory versus field spectroscopic measures of nitrogen content and *in vitro* DMD.

Location/time	1/ July 00	2/ September 00	2/ November 00	Overall
r^2 for nitrogen	0.995	0.870	0.939	0.807
r^2 for *in vitro* DMD	0.997	0.984	0.890	0.571

In each location/time situation (Table 1), the r^2 for N and IVDMD concentrations accounted for 87-100% of the observed field variation. The overall r^2 for N declined to 81% when analysed across the 2 locations and the 3 sampling times. However, for IVDMD, the overall r^2 declined to 57%. The likely reason for the low r^2 in the overall case was the high variation in the concentration levels in specific locations and/or specific times. The overall calibration scheme some fine-tuning to robustly predict N and IVDMD variation due to site and time of sampling. This study suggests that N and IVDMD contents can be spatio-spectroscopically modelled with reasonable accuracy to match the results of the reference method. The success of this study allows direct extension of this methodology to airborne/space borne hyperspectral imagery obtained from sensors such as Hymap and Hyperion. Our objective is to deliver real-time information directly to end-users in the form of forage biomass, growth rate and quality.

EDIRISINGHE, A., DONALD, G., HENRY, D.A., MATA, G., GHERARDI, S.G., OLDHAM, C.M., GITTINS, S.P. and SMITH, R.C.G. (2004). *Anim. Prod. Aust*. **25**, (This proceedings).

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