Proximal sensing pasture composition

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Ieda Sanches and Mike Tuohy are using an ASD FieldSpec® Pro FR attached to the CAPP (canopy pasture probe) to gather pasture reflectance data as a means of rapidly assessing pasture composition.

New Zealand pastures are normally composed of two or more species, frequently a combination of ryegrass and clover. These species complement each other, since grass species provide the majority of herbage and the legume species fixes nitrogen in the soil and has a great nutritive value. For best pasture management, some knowledge of the different proportions of species in the pasture is useful information. The ideal would be to have a quick and non-destructive method to obtain this information. The objective of the present study was to evaluate the possibility of predicting the botanical composition proportions of New Zealand pasture species using proximal remote sensing techniques.

Pasture reflectance were obtained in situ using an ASD FieldSpec® Pro FR spectroradiometer under artificial illumination provided by the Canopy Pasture Probe - CAPP. The ASD FieldSpec® Pro FR has three detectors covering the spectral range between 350-2500 nanometres (nm).

To acquire spectral measurements a stable illumination is required, and since rapidly changing weather conditions (mainly cloud cover) are characteristic for New Zealand, the CAPP was developed. The CAPP consists of an inverted black plastic bin, with a light source mounted on the top (at zenith) and an input for the spectroradiometer fiber optic placed at 18 degrees from zenith. This allows the acquisition of weather-independent spectral measurements of pastures in the field even on cloudy days.

The dataset, consisting of spectral reflectance data and pasture samples, was collected between August 2006 and June 2007, at four dairy and two sheep farms in the North Island of New Zealand.

Overall 361 pasture samples were collected and separated into the main botanical components: grass, legume and weeds. Subsequently, the percentages of each component were calculated. The identification of each species was not a priority in this study, but among the samples collected the majority of grass species were ryegrass and browntop, the most common legume species was white clover, and weeds species were buttercup, catsear, chickweed, dock, hydrocotyle, plantain, red dead-nettle, thistle and yarrow.

The reflectance spectra acquired were first pre-processed to eliminate the undesirable features, such as spectral noise, that might compromise the data analysis. For analysis of the relationship between the pre-processed spectral data (420-2468nm) and the botanical composition pasture variables (%grass, %legume and %weed), the statistic method used was partial least squares regression (PLSR). PLSR was chosen because there is a large amount of data and the predictor variables (361 reflectance spectra over 2040 wavelengths) are highly correlated. That means there is redundant information, but rather than select a few of the predictor variables, it is better to reduce their number to a few components. In PLSR the components are linear combinations of the predictor variables chosen so that they describe as much of the variation in the predictors as possible and also give extra weight for variables that show a high correlation with the response variable (percentage of botanical composition).

To run the PLSR, the total sample set (n=361) was randomly divided into calibration and validation (prediction) data sets, representing 70% and 30% of the samples, respectively.

Considering that all botanical variables had a similar range of values (varying from zero to 100%), based on the R2, the worse prediction was obtained for percentage of weeds. That was expected because several distinct types of plants (buttercup, catsear, chickweed, dock, hydrocotyle, plantain, red dead-nettle, thistle and yarrow) with distinct types of leaves and plant structure were put under the same classification group (weeds). On the other hand the grasses present the same kind of plant structure, and legumes also had similar structure. The error (RMSE) obtained around 10% is still a little bit high, and for practical applications it would be good to have an error under 5%. Other processing techniques can be applied to the spectral data to improve the results.

The results presented here show that there is potential for proximal sensing of the botanical composition of New Zealand pastures, which needs to be explored further.

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