MEASURING PASTURE QUALITY IN THE FIELD: A CASE STUDY AT LIMESTONE DOWNS

Ian Yule, Reddy Pullanagari and Pip McVeagh

NZ Centre for Precision Agriculture, Massey University
Private Bag 11 222, Palmerston North 4442, New Zealand

Abstract

Good pasture utilisation and management are essential for optimal productivity on hill country farms. Achieving a highly productive pastoral system requires high quality feed; focusing simply on producing large quantities is not enough. For farmers, the ability to collect near real time information on pasture quality and build a picture of the spatial variation of pasture quality over their property would allow them to better manage their grazing system. Improved pasture utilisation through better allocation of pasture would enable higher productivity to be achieved.

Hyperspectral analysis is potentially a valuable option. Optical sensors have been used on dairy pastures throughout New Zealand to measure in-situ pasture quality with success. Optical instruments which measure the reflectance of pasture within a range of wavelengths were used to estimate the pasture quality parameters: crude protein, metabolisable energy (ME) and in-vitro organic matter digestibility (OMD).

Fieldwork, supported by the C. Alama Baker Trust, was carried out at Limestone Downs, a hill country property near Port Waikato. Hyperspectral technology used to measure pasture quality in near real time showed great potential. 105 pasture samples from seven sites were taken from the property. Wet chemistry analysis of these samples were compared against green pasture measured infield using an ASD Field Spec® Pro and a FieldSpec HandHeld 2™, dried and ground samples were also measured with the ASD Field Spec® Pro. Significant variation of pasture quality was found between the sites. High levels of explanation of crude protein (r^2 0.81), ME (r^2 0.83) and OMD (r^2 0.85) were achieved from measuring living pasture in-situ using the ASD Field Spec® Pro. The level of explanation achieved for the FieldSpec HandHeld 2™ was reduced but still useful.

Key Words: Precision Agriculture, pasture quality, hyperspectral sensing, sheep and beef, hill country farming

Introduction

In recent years the importance of the consideration of pasture quality as well as quantity in allocating pasture to livestock has increased in the New Zealand farming scene. Particularly so for those in the dairy industry but, it is important for sheep and beef farmers as well. Although sheep and beef cattle are able to survive on a wide range of pasture, achieving optimal productivity on hill country farms requires high quality feed; focusing simply on producing large quantities of fodder is not enough. Managing pasture quality may now be one of the bigger opportunities sheep and beef farmers have to improve their financial performance. Pasture quality has a major effect on the performance of grazing animals, including improved live weight gains, milk production, fibre production, health and reproductive performance.

Pasture quality varies greatly on hill country farms but, farmers tend not to measure pasture quality mainly because of the time and expense involved. Although laboratory based herbage tests to analyse pasture quality hold very useful information. Traditionally pasture quality has been assessed using destructive sampling and laboratory analysis of dried ground pasture samples. At $200 a sample for wet chemistry, a laboratory based pasture quality analysis is expensive. This process also takes some weeks for the results to be sent to the farmer. An infield, non-destructive, near real time and inexpensive method of measuring pasture quality would be of great benefit to farmers. However Lab NIR is also available, which is a cheaper option with a faster turned than wet chemistry analysis.

Proximal hyperspectral sensors have the potential to predict in-field pasture quality rapidly and non-destructively. Previous work by Pullanagari *et al*. (2012) has shown the ability of hyperspectral sensors to predict pasture quality parameters with his research carried out on New Zealand dairy pastures.

Methods

The ASD Field Spec® Pro and the Field Spec Handheld-2 ™ were used to record spectra of living plant material at each of the 15 plots around the site. 105 samples were taken from seven different sites, see Figure 1.

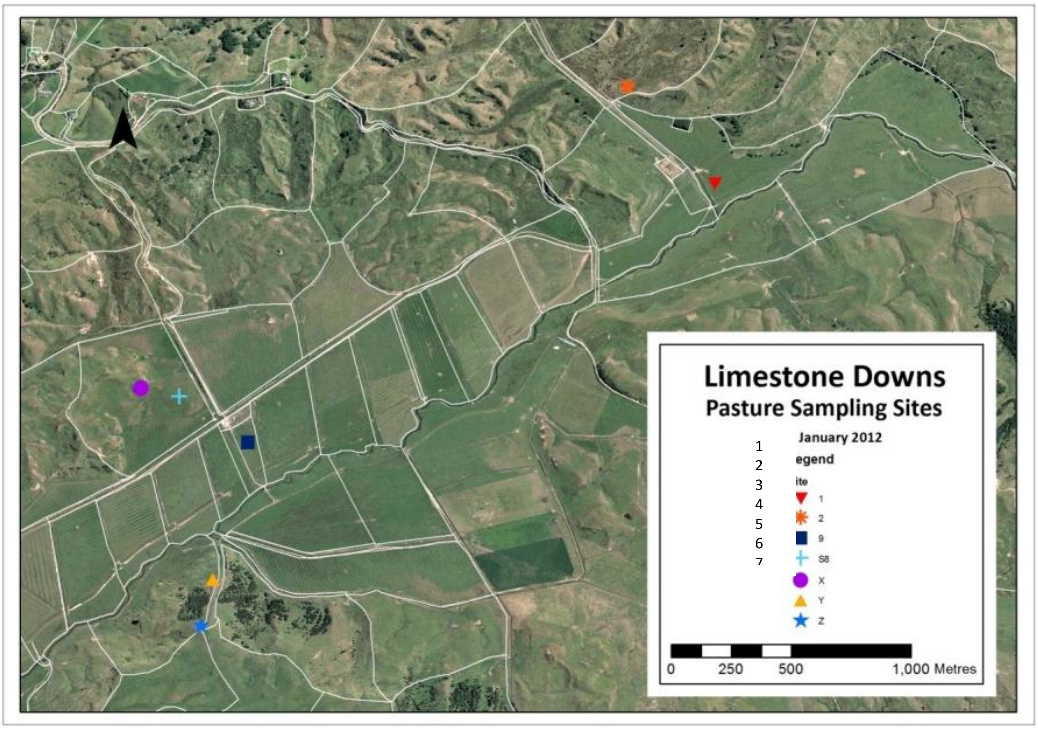

Figure 1: Pasture sampling sites, Limestone Downs.

The pasture samples were then cut to ground. They were dried and ground and sent off to the laboratory for wet chemistry analysis for crude protein content, metabolisable energy and In-vitro organic matter digestibility. A sub sample of the ground and dried sample was taken and measured with the ASD Field Spec Pro® as a bench top set up.

The spectral data from these instruments were analysed and regressed using the partial least squares regression method against the reference values which were measured values from the chemical analysis. PLSR method is a popular multivariate statistical method that has widely been used in chemometrics. This method is very useful when dealing with numerous predictive variables. In our case, with the spectral data analysed, the number of predictive variables is 2150 wavelengths. This method allows information from high dimensional (2150 wavelengths) to be extracted to low dimensional data which are closely related response variable such as crude protein, fibre and metabolisable energy. Therefore, we are likely to get reasonable results using this method.

Results and Discussions

Three pasture quality parameters metabolisable energy, crude protein and In-vitro organic matter digestibility, were estimated from the data collected. Strong correlations (R^2:0.95-0.96) were observed between reference and spectral values obtained from dry vegetation (Figure 2). Reasonable correlations (R^2:0.80-0.85) between reference and spectra was obtained in the field. However, the level of explanation with the Handheld unit (R^2:0.68-0.73) was decreased with the short spectra range sensor and use of ambient light. The study demonstrates the likely performance of currently available instruments. All results are summarised in Table 1.

Table 1: Results of Hyperspectral analysis of pasture samples from Limestone downs.

Sample	Metabolisable Energy (ME)		Crude Protein (CP)		Organic Matter Digestibility (OMD)	
	R^2	RMSE	R^2	RMSE	R^2	RMSE
Dry Sample Spectra	0.95	0.20	0.96	0.75	0.95	1.44
Green Vegetation spectra. In-field ASD Field Spec Pro.	0.83	0.34	0.80	1.66	0.85	2.63
Green vegetation spectra. In-field ASD Handheld 2	0.74	0.46	0.69	2.09	0.76	3.27

The impact of light intensity on the experiment is evident. Adequate and stable light intensity is crucial to obtain consistent results from the spectral data. Normally, in remote sensing studies, the light intensity should be in between 400-1200 w/m2. However, in New Zealand, the natural illumination (sunlight) intensity is unstable. Therefore, in this study, we used artificial light source to act as incident radiation. A Canopy Pasture Probe (CAPP) developed by Sanches (2010) was used to block ambient light and illuminated using a Tungsten-Quartz-Halogen lamp as the artificial light source. If incident or natural light is to be used then the ambient lighting conditions would have to be taken into account to achieve accurate calibration. However in this study reasonable results were obtained using the ASD Handheld, which relies on ambient light to illuminate the area being sensed.

The results from the analysis indicated that the sensor with wide spectral range has a high level of explanation of the pasture quality data from the chemical analysis. Figure 2 illustrates

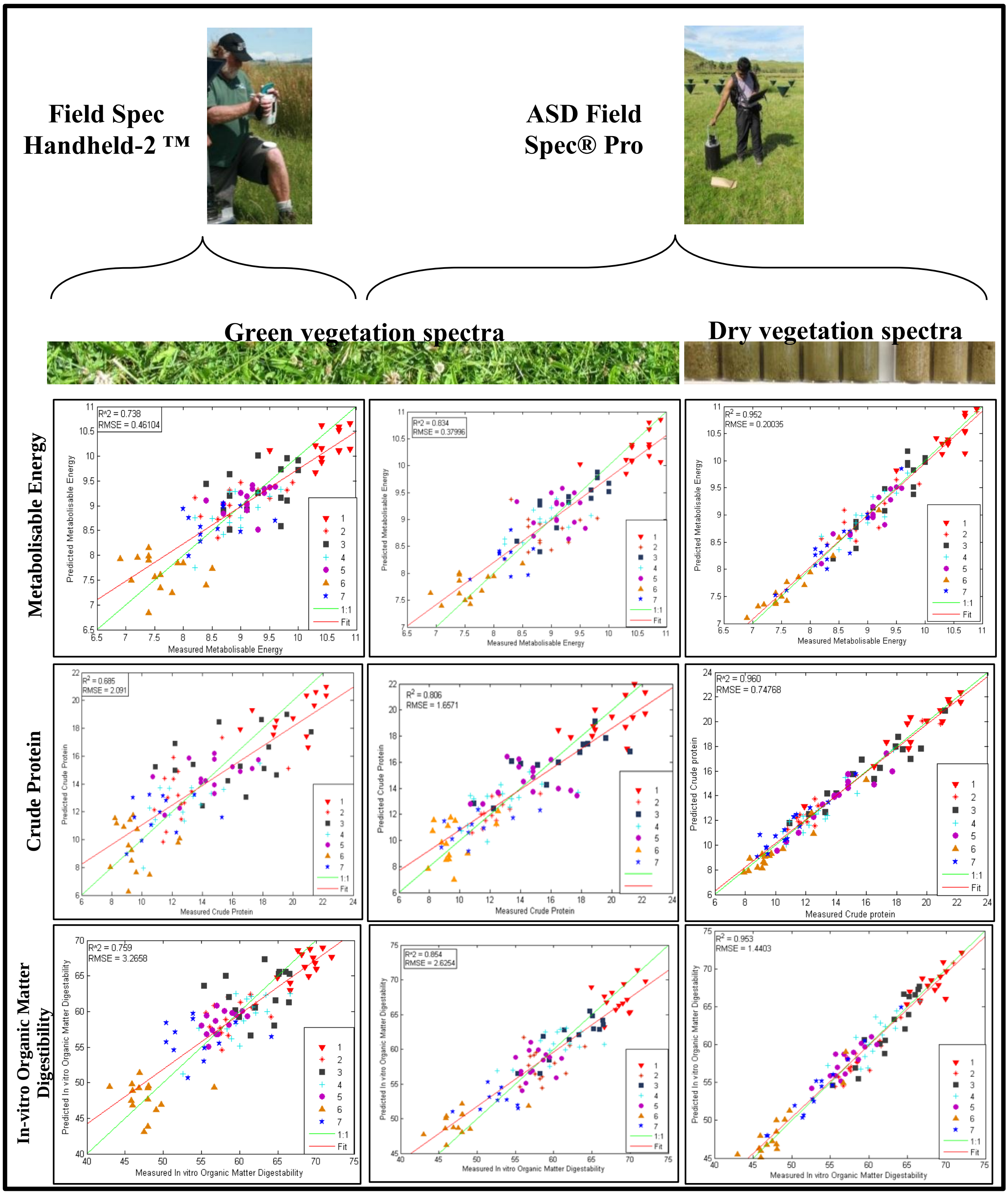

Figure 2: Results of the wet chemistry analysis (x axis) and analysed spectral data from the ASD Field Spec® Pro and the Field Spec Handheld-2 ™ (y axis) for metabolisable energy, crude protein and In-vitro Organic Matter Digestibility.

In Figure 2 different symbols represent different site locations and pasture nutritive values clearly changed with location as observed from the clustering of alike symbols in the figure. There is much greater variation between sites than the variation within each site. This indicates that there could be significant management value in this information if it could be used in a near real time way.

Conclusion

These findings demonstrate the potential of hyperspectral sensing to determine nutritive values of pasture on hill country properties. The results show large differences, greater than we expected, in pasture quality in terms of crude protein, In-vitro organic matter digestibility and metabolisable energy. The results also showed that pasture nutritive values clearly changed with location. The ability to quantify pasture quality and quantity will be a considerable advantage to hill country farmers and allow them to better plan their grazing decisions. Matching current pasture supply on farm with animal nutritional needs, especially at crucial times, to ensure that target or optimal animal performance is met, clearly requires knowledge of pasture availability and its quality. Accurate, non-destructive, near real-time, infield estimation of pasture quality would enable farmers to adopt more precise management techniques which would result in better utilisation of pastures, improved stock performance and increased profits.

References

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