PASTURE YIELD MAPPING FROM YOUR GROUNDSPREAD TRUCK

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Abstract
There is considerable interest from farmers in measuring their pasture production. Dairy farmers in particular want to improve feed budgeting as well as increasing the efficiency of fertiliser use. While many have shown interest by investing in technology such as the C-Dax pasture meter, others are resistant to spending time on this task. One possible solution is to utilise the fact that a fertiliser spreading truck travels over the farm on a regular basis and at crucial periods where decisions around fertiliser application are being made.

Pasture biomass can be estimated by using a VIS/NIR sensor, this type of non-contact, optical sensor is used to produce a measurement called NDVI (Normalised Difference Vegetation Index), a surrogate of it or an alternative ratio of reflectance in the visible and near infrared ranges of the electromagnetic spectrum. There are a number of manufactured sensors available; the sensor used in this trial was the CropSpec™ from Topcon. These sensors can be fitted to the roof of the truck and linked directly to the GPS navigation assistance system of the vehicle.

This initial work examined the performance of the sensor and discusses the feasibility of using this approach. The possible uses of the technology are to provide pasture cover maps for the farmer and provide the basis for variable rate application of N fertiliser. This would be done by either reducing or eliminating further application of nitrogen fertiliser once the NDVI reached predetermined levels.

Introduction
An increasing number of farmers realise the value of pasture feed budgeting on their farm in order to optimise pasture utilisation and animal feed conversion. A number of methods are available but the C-Dax Pasturemeter has become the most popular method for farmers to use in recent years. It is a significant advancement from previous technology as it allows rapid measurement of pasture using an ATV. However not every farmer wants to, or is able to, measure their own pasture and may be interested in ways where this information could be generated for them.

There is also increasing awareness of the need to use N fertiliser efficiently and prevent over-application of fertiliser. A sensor based system which could evaluate the pasture cover and condition ahead of the truck could make these decisions on-the-go and vary the rate of fertiliser applied accordingly. The spatial resolution at which this data can be collected is limited by the swath widths which the truck drives due to the wide spreader footprint.

In this case study a groundspread fertiliser truck was used during a spreading operation to sense the pasture. The sensing options from such a vehicle are limited due to the size of the truck and the speed of movement. VIS/NIR sensors were investigated as a possible means of estimating pasture cover. Three sensors were evaluated but only one, the Topcon CropSpec™, was considered suitable. These sensors work in pairs and could be mounted on the cab of the truck scanning a swath either side of the vehicle. The principles of operation are explained in Figure 1.

The proportion of solar radiation absorbed or reflected by vegetation at each wavelength depends on biomass and condition. Figure 1 illustrates the difference in reflectance of incoming solar radiation between healthy and stressed vegetation. In the visible part of the electromagnetic spectrum healthy vegetation absorbs more light (therefore it reflects less), while in the near infrared part of the electromagnetic spectrum healthy vegetation reflects more than stressed plants (N deficient for example). The sensor measures the reflectance at specific wavelengths and the values measured can be used to calculate indices formed from the measurements around the VIR/NIR part of the spectrum. Most dramatic changes happen around the "red edge", 670 – 770nm. Yule and Pullanagari 2010, listed a number of these indices in previous proceedings.

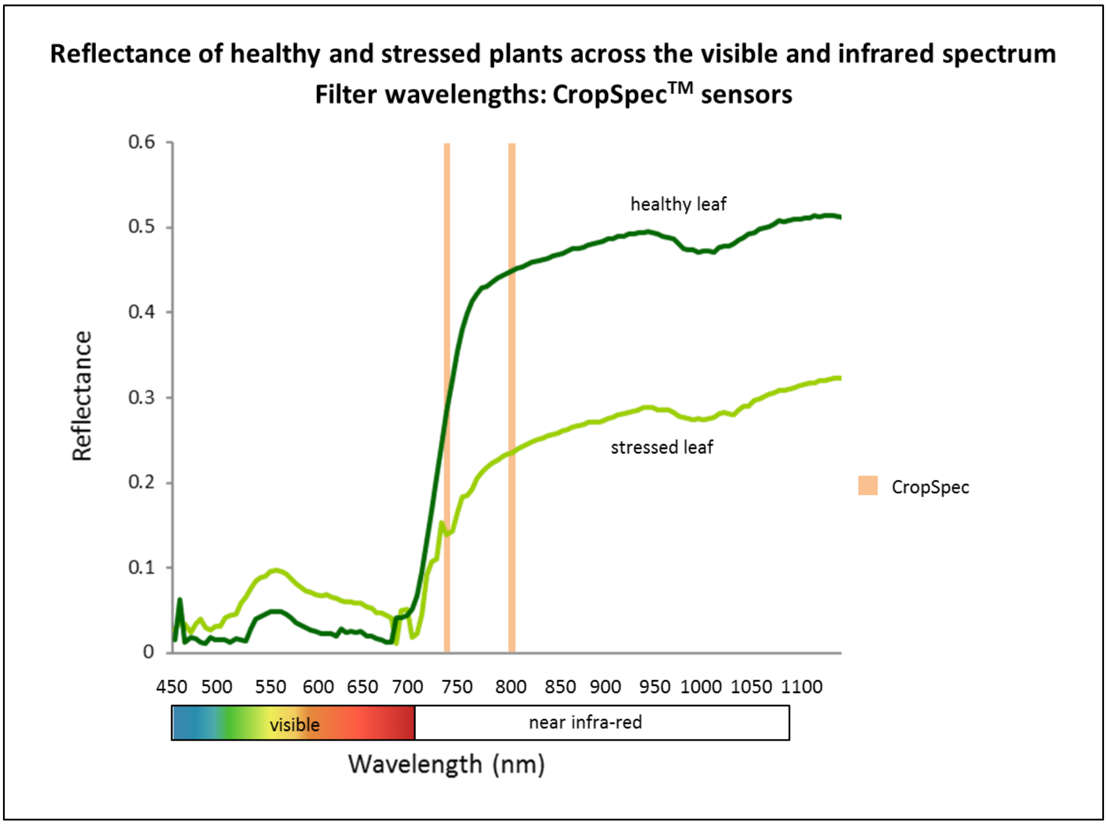

Figure 1: Reflectance of healthy and stressed plants across the visible and infrared electromagnetic spectrum, CropSpec™ filter wavelengths marked by orange lines

The sensor used can also communicate directly with the same on-board computer which is connected to the GPS guidance of the vehicle and spreader control system. The purpose of this test was to see if the method was technically feasible. No attempt has been made to ascertain the economic value of this mapping to the farmer or investigate if farmers would be prepared to pay for the information generated. This paper describes an initial experiment conducted in December 2011 on Pickwick Farm, near Wanganui.

Methods and Materials

A trial was conducted where pasture biomass within paddocks was measured using a variety of means. The C-Dax Pasture meter, rising plate meter (conducted by the staff of the farm) and the CropSpec^{TM} sensor were used and tested against multiple cuts taken from the paddocks to estimate pasture biomass.

The CropSpec^{TM} sensor is an active sensor using a laser light source. The wavelengths detected by the sensor are centred around 730nm (red) and 800nm (NIR) +/- 10nm, see figure 1. At 2.884m, the height of the truck roof over the cab is within the 2-4m height range for the CropSpec^{TM} sensors. This gives a footprint of approximately 3m on the ground either side of the truck, covering from 2 to 5m away from the side of the truck. The position of the sensors can be seen in Figure 2.

Figure 2: CropSpec Sensor mounted on cab roof.

The data recorded from the Cropspec^{TM} sensor and the C-Dax Pasture meter gave coverage of the whole paddock, but the same tracks or sampling areas were not used because of the different footprint of the sensor and the driving pattern. However a regular pattern of measurement was used in both cases and a raster grid of the measurements taken within each paddock was formed.

Pasture cuts were taken from a variety of positions over individual paddocks, these were cut to ground and removed for drying and DM estimation. The plate meter readings were taken from the farmers regular pasture walk which was three days prior to the other measurements.

Discussion

The CropSpec sensors where mounted and run simultaneously with the fertiliser spreading job. The sensor data collected from the CropSpec sensors can easily and quickly be mapped. This information could be provided to the farmer as an additional service. This gives the farmer an indication of the relative pasture cover in each paddock.

The C-Dax pasture meter came closest to the pasture cuts carried out. The plate meter was the least accurate even when the fact that measurements were taken three days previous was taken into account. The results from the farm constantly underestimated pasture cover. The CropSpec sensor performed much better than the plate meter in the high and medium biomass paddocks. However it did underestimate the pasture dry matter in freshly grazed paddocks. This is likely due to the nature of the vegetation reflectance signal from grazed pasture where leaf material has been removed and only stalky material left.

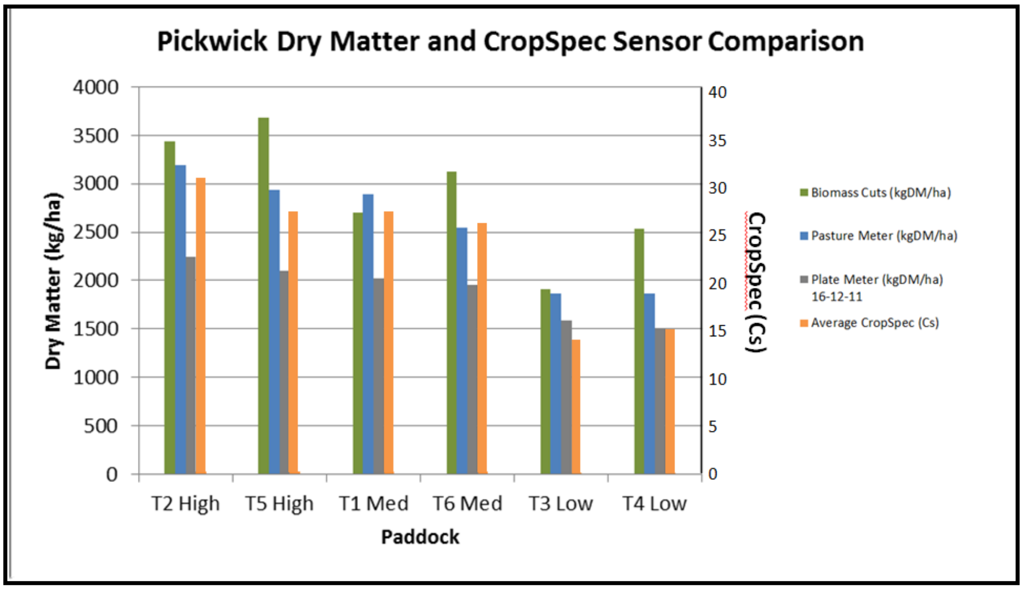

Figure 3: Comparison of dry matter from three different methods: Biomass cuts, C-Dax pasture meter and plate meter, with CropSpec.

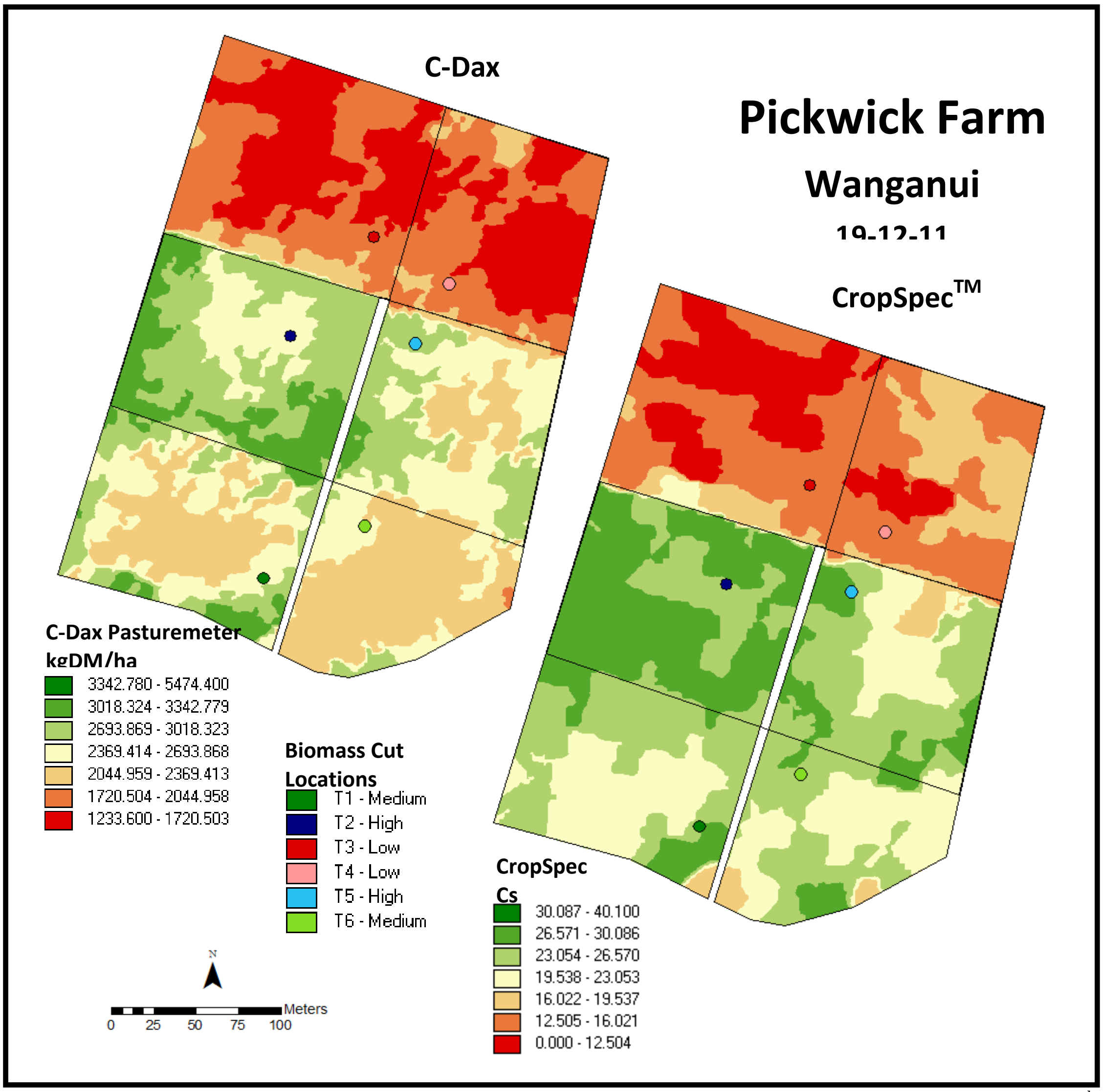

Figure 4: Maps created in FarmWorks of C-Dax pasture meter data and CropSpec data taken on the 19th December 2011 at Pickwick Farms, Wanganui

Proximal sensors, such as Topcon's CropSpec™ sensor, can provide real time data on the crops condition. A sensor such as this can be used at the time of fertiliser application. Nitrogen application can be altered "on the go" when a sensor is linked to a spreader with variable rate application technologies (VRAT). Nitrogen application rates can be calculated and adjusted to match requirements at any given location in the paddock. This optimises the use of nitrogen based fertilisers.

The CropSpec's calculated Cs value would be used to determine the rate of N fertiliser spread at each location in the paddock. The rate of N fertiliser applied would be reduced or eliminated when the Cs value reached the threshold of predetermined categories. Thresholds used to set rates of fertiliser applied depend on the time of year. More information based on NDVI or surrogate NDVI values such as Cs is required to determine suitable thresholds. Factors such as season, pasture species and time since last grazing would alter the appropriate thresholds.

Conclusions

This initial pasture yield mapping using a CropSpec™ sensor indicates that pasture cover maps can be created from the data collected from the spreading truck. The economic benefits of such pasture yield mapping is unknown but as more farmers are using feed budgeting as a management tool, pasture cover maps would be of greater interest.

The CropSpec™ sensor value Cs can be used as the basis of variable rate fertiliser application to use N fertilisers more efficiently. However to determine appropriate thresholds for the rates of fertiliser applied, a clear understanding of factors that affect the Cs values such as season, pasture species and time since last grazing need to be clearly understood.

Acknowledgements

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References

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