PASTURE MONITORING TECHNOLOGIES

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Introduction

Background of Precision Agriculture

Precision Agriculture (PA) has been around for many years. The basic concept of the technology is to identify spatial variability and to manage a particular crop/land resource accordingly. This is achieved by the variation of inputs or treatments typically using three tools: Global Positioning Systems (GPS); Geographical Information Systems (GIS); and sensor technology. PA evolved from the ability to create yield maps from cereal crops; the initial theory was to maximise production by increasing yield of low potential zones. This concept has been replaced with the theory of maximising economic efficiency from variations in land classification. In many cases this may mean an increase in production in areas of higher productivity, whilst reducing inputs on areas of lower productivity optimising the economical potential of the land resource.

The shift from measurement to management

Previously, PA tools have been developed to measure certain aspects of crop or soil, but in order for PA to be economically sustainable, the measurement aspect of PA is required to be supported by robust decision making and management processes. Recent examples of PA management systems successfully adopted in New Zealand agriculture include:

1. Multiple yield maps to evaluate variable rate planting of Maize
2. Seed rate variations based on soil EM results
3. Irrigation scheduling from soil EM surveys
4. Using NDVI to selectivity harvest grapes.

Precision Agriculture for dairy farmers

PA technology has long been seen as a tool for arable farmers (previous developments in Europe and USA support this), however, New Zealand pastoral farming (dairy and sheep and beef) make up over 85% of rural land use. This prompted research staff at the NZCPA to investigate the opportunities of PA systems in NZ pastoral farming. The prominent issue in the dairy sector was the ability to provide accurate feed information for feed budgeting purposes. The NZCPA have developed, and will continue to develop, a number of tools specifically designed to improve measurement and management systems within dairy farming systems.

Objectives

This paper describes the development of the *Rapid Pasture Meter*© and combined management software as a PA tool for dairy farmers. Also discussed are other PA tools currently being developed by the NZCPA for use on New Zealand dairy farms. These include: pasture quality monitoring, fertiliser application monitoring, and GPS cattle tracking.

Discussion

Development of the Rapid Pasture Meter©

Traditional methods of pasture measurement suffer from a number of problems, including: slow pedestrian based systems, limited sampling capability, and variability in results. The *Rapid Pasture Meter*© described here provides fast, accurate, and repeatable pasture cover information to the user over a variety of pre- and post-grazing conditions. The system has three tiers, enabling every farmer to spatially manage their pasture resource irrespective of technological skills. The three tiers of the *Rapid Pasture Meter*© are:

- *Tier 1*: Simple start/stop measurement with manual recording and input to bundled farm management software
- *Tier 2*: Record on board, multiple paddock recording, wireless download to bundled farm management software
- *Tier 3*: GPS enabled to create pasture yield maps, GIS data mining technology to identify growth zones, bundled with advanced farm management software.

Rapid Pasture Meter© *for farmers*

As a tool for farmers the *Rapid Pasture Meter*© offers a series of benefits including: speed of data collection; repeatable results; and ease of data management. On a series of on-farm trials conducted throughout New Zealand, results have indicated that the technology is robust and stands up to day to day use. The tool has been used for tactical management (whole farm measurement) as

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well as within a daily management routine (pre and post grazing measurement) to calculate accurate herd intake information and supplementary feed recommendations. Figure 1 shows data collected from the *Rapid Pasture Meter*© at pre- and post-grazing. From this data the quantity of pasture removed from the paddock could be mapped (Figure 1) and statistics extracted (Table 1). This can be used to identify areas of poor pasture utilisation for individual grazing events which could affect pasture quality at a later stage of the production season.

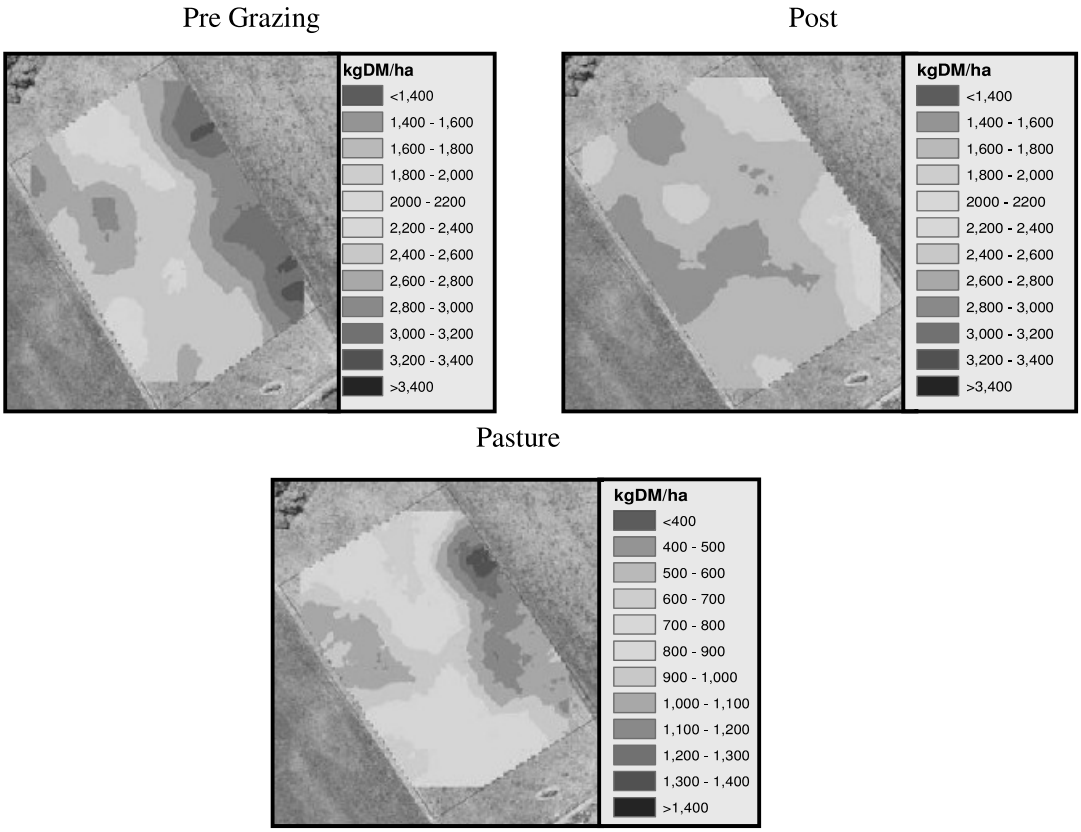

Figure 1: Pre grazing, post grazing, and pasture removal maps measured using the *Rapid Pasture Meter*© on Massey No. 4 dairy farm.

Table 1: Pre grazing, post grazing, and pasture removal statistics measured using the *Rapid Pasture*

	Average Cover (kgDM/ha)	**Max Cover (kgDM/ha)**	**Min Cover (kgDM/ha)**	**S.D Cover (kgDM/ha)**
Pre Grazing	2645	3277	2244	240
Post Grazing	1724	2175	1465	142
Pasture Removed	916	1350	611	154

Meter© on Massey No.4 dairy farm.

The *Rapid Pasture Meter*© creates accuracy and repeatability in post-grazing measurement which, before now, has been unachievable. Another benefit of using pre- and post-grazing measurement using the rapid pasture meter is the ability to identify pasture growth rates between grazing of individual paddocks. A permanent record can be electronically stored and compared to a variety of inputs and outputs including milk production records, fertiliser history, re-grassing strategies and/or capital land improvements (ie, drainage/irrigation etc.). The *Rapid Pasture Meter*© has found acceptance on a wide range of commercial farms throughout New Zealand and will be continually developed to aid in on-farm pasture monitoring.

Rapid Pasture Meter© *for research*

As a tool for commercial research the *Rapid Pasture Meter*© can be used to evaluate differences between large scale paddock treatments of grass cultivar or fertiliser treatments. Research trials can now be evaluated on a farm/field scale rather than plot scale. Figure 2 shows an example of how the *Rapid Pasture Meter*© is currently been used in research trials.

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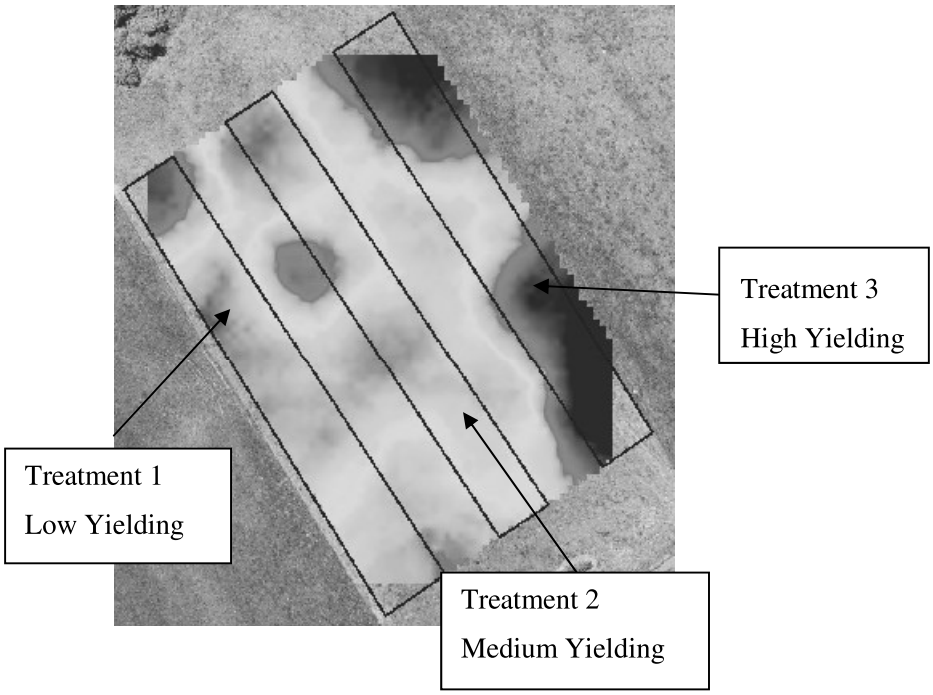

Figure 2: The *Rapid Pasture Meter*© is seen as a valuable tool in conducting research trials at the paddock and farm level rather than using traditional plot measurements.

Other precision dairying tools

Pasture quality monitoring

Using NIR sensors attached to an ATV, it is now possible to measure the parameters associated with pasture quality. The NIR sensor measures the normalised difference vegetative index (NDVI) which correlates to the chlorophyll levels in the plant. It is envisaged in the future that the energy value of grass (MJ ME/kg DM) will be able to measured alongside pasture dry matter. This product is most likely to be developed in conjunction with the *Rapid Pasture Meter*©.

Fertiliser tracking

The cost of inaccurate fertiliser application can now be successfully quantified using equipment already installed on ground based spreading vehicles. A method devised using measured machine parameters, GPS, and GIS allowed true field application rates to be measured at a spatial resolution of $1m^2$. It was calculated from this data that New Zealand dairy farms are losing between $50 and $70/ha/yr due to poor fertiliser application (Lawrence & Yule, 2007).

GPS cattle tracking

Methods have been successfully developed to measure the grazing behaviour of dairy cows over a long period of time. GPS collars were placed on two dairy cows to measure their movements. The collars proved a viable means of collecting meaningful data on the movement of the cows around the farm with relation to grazing, ruminating and drinking intervals. The average time spent grazing in each period by the collared cow was 3.18 hr (3hr 11min); there was no statistical difference between times spent grazing during the AM and PM periods. However, because the PM grazing period is longer, the percentage of time spent grazing during the AM period is proportionally higher. The average time per grazing interval before a change in activity occurred was calculated to be 1.07 hr (1hr 4min).

Conclusion

The change in focus from measurement to management was seen as vital in order for PA tools to be successfully adopted into New Zealand farming systems. This paper describes precision agricultural tools devised specifically for New Zealand dairy farms. The development of the rapid pasture meter to quickly and accurately measure and record pasture data is seen as a major step forward in the adoption of PA in New Zealand farming systems. Other PA systems that are currently under development within the New Zealand Centre for Precision Agriculture are also discussed.

References

Lawrence H G and Yule I J. 2007. A GIS Methodology to Calculate the In-field Dispersion of Fertiliser From a Spinning Disc Spreader. Transitions of the American Society of Agricultural and Biological Engineers 50(2): 379-387.

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