PRECISION AGRICULTURE
11TH ANNUAL SYMPOSIUM

Friday 14th of September 2007

Japan Lecture Theatre
Massey University
Palmerston North
New Zealand

NEW ZEALAND CENTRE FOR PRECISION AGRICULTURE

Massey University
COLLEGE OF SCIENCES

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11th Australasian Symposium on Precision Agriculture

Convenor: Dr Ian Yule

WELCOME

Welcome to Massey University for the 11th Annual Australasiona Symposium on Precision Agriculture. This is the first time it has been held in New Zealand. I would especially like to thank the Australian delegates who have made the effort to come over for this meeting. We hope thay have an enjoyable trip to New Zealand and we are very pleased to host you here in Palmerston North.

The Symposium has been run for the previous ten years by the Australian Centre for Precision Agriculture based at the University of Sydney. This year's event follows a similar format to the Sydney meetings but the subject matter more closely reflects New Zealand agriculture and viticulture. There is also a significant contribution from Australian presenters and we are glad to have the opportunity to present their work to a mainly New Zealand audience.

The first morning session is heavily orientated towards farmers' experiences with precision agriculture. In New Zealand guidance and autosteer has seen greater uptake than yield mapping. Hayden Montgommery from MAF also examines the effects of changing consumer demands and government policy on the shape of our farming future.

One of the areas of concern for New Zealand and Australian producers is water use efficiency; this is covered with three presentations related to irrigation performance and the opportunities for variable-rate irrigation. Further presentations cover topics of precision agriculture management, uptake of technology and further sensor development.

The first afternoon session has a viticultural and horticultural flavour with presentations on vineyard management and the use of NIR to determine harvest strategies. Remote and proximal sensing technologies are also covered. The final session of the day is devoted to precision dairying and automation. This is the first time this has featured in the Symposium and reflects the work done in New Zealand in this area. There is also considerable interest in this area in Australia.

We hope that you find this Symposium stimulating and relevant and hope that a few more Kiwis will be able to join us next year in Sydney for the 12th Annual Symposium.

Session 1: 8.45am –9.05am.
John Austin, *John Austin Ltd*

Biography:

John Austin has built a highly successful contracting business from a one man band after leaving school. His business is probably the largest of its kind in New Zealand and it is built on some fundamental principles around offering a high quality service. John has a passion for new ideas which has enabled him to assist with the development of new technology such as the testing of grain yield monitors in the early 1990's and forage yield monitors more recently. John Austin Ltd has yield mapped more of New Zealand than anyone else and the company is at the forefront of using agricultural technology for guidance, mapping and fleet management.

Utilising Precision Agriculture Technologies – abstract not submitted.

Session 1: 9.05am – 9.25am.
David Clark, *Clark Farming Group*

Abstract:

Controlled Traffic Farming.

Opou Station is now in their 5th year of operating an RTK GPS Precision farming system. The basis of the system is controlling the traffic in the paddock through the growing season and Strip tillage in the autumn following harvest. RTK enables the planter to plant directly into this strip in the spring as soon as ground conditions allow, with no further cultivation. All machinery wheel tracks are matched at 10 feet and the row width chosen is 30 feetG

Session 1: 9.25am – 9.45am.
Hew Dalrymple, *Farmer Manawatu*

Strip tillage cultivation – abstract not submitted.

Session 1: 9.45am – 10.05am.

Mike Smith, *Farmer NSW*

Biography:

I have been farming at "Tarnee" since 1983 since returning to the family farm from an on/off affair with university, and have been involved with local conservation farming groups (Moree Conservation Farming Association and Conservation Farmers Inc, now merged into CFI) since that time.

My interest in precision agriculture began in 1996 and has lead to our current involvement with the Australian Centre for Precision Agriculture and research projects with the Grains Research and Development Corporation.

Abstract:

A PA farming system in Northern NSW and the economics of variable rate

Our farm is located in northern NSW, approximately 40km SE of Moree. The farming system is driven by the need to conserve the soil and store water in a variable landscape and climate. Rainfall averages 600mm with 200mm in the winter crop growing period May-Oct. We employ a no-till controlled traffic cropping program including both winter and summer crops to provide an integrated program to manage weeds, diseases and production risk. A typical rotation would be Durum wheat (sown late May: harvest Nov), Corn/Sorghum (sown late Aug/Sept: harvest Jan/Feb), Double crop Chickpeas (sown May: harvest Nov). Sometimes a second cereal (wheat/barley) could be added after the first or Safflower as a later plant (Jul) option.

Our foray into precision agriculture was driven by the variability of our soil depth, a black vertisol, overlaying a decomposing sandstone. Since our cropping program relied heavily on stored water to produce crops, it only made sense to look more closely at the relationship between yield and the soil depth. Along the way we have had the opportunity to try a number of tools to help describe the soils' capacity to produce: Veris 3100, EM 31, 38 H & V, Radio Gammametrics, Protein mapping and of course, yield mapping.

Subsequently the farms' fields are now divided up into production zones based upon the data gathered. Most fields are divided into 3 zones expressed as a percentage of the average potential, with the farm breakdown being 121% in the top zone, 97% and 67% for the others. All fertiliser is applied along these lines. Sowing rates may also be varied to account for different population requirements (weed competition, production potential, field germination etc).

Through all of this we are achieving savings from the redistribution of fertiliser against applying a flat rate across the field. These savings, based on historical data, are around $12-14 per ha per year, and if applied going forward using current costs $22 per ha per year.

Session 1: 10.05am – 10.25am.
Hayden Montgomery, *MAF*

Biography:

Hayden is a senior analyst at the Ministry of Agriculture and Forestry (MAF). He joined MAF after working in various jobs including agriculture and science policy research at The University of Auckland, New Zealand, a short period as a policy researcher at the Office of the Chief Scientist Health Canada. He has been a member of the New Zealand delegation at the United Nations Climate Change meetings since 2006. Current work at MAF includes international climate change policy, agriculture climate change research policy.

Abstract:

Farming for the Future: considering consumer and environmental demands.

In this presentation I will discuss the domestic and international environmental policy context for agriculture, including climate change (mitigation and adaptation), water use and quality, and sustainable land management. I will explore some of the changes in consumer and retailer demands in some key markets that are driving changes in the value chains that New Zealand's primary industries participate in. There is an increasing expectation that products have been produced sustainably, and that this can be verified. In some key export markets there is increasing pressure for information on the GHG intensity of products throughout their life-cycle and we can expect that into the future, demands for sustainability credentials will be wider than solely GHG footprinting. Precision agriculture is a means to farm more efficiently, producing fewer of the environmental externalities that markets penalise us for, and from a finite land resource. I will identify some of the key gaps in knowledge and information and discuss the role of precision agriculture in helping to address these many challenges.

Session 2: 10.40am – 11.00am.
Carolyn Hedley, *Landcare Research*

Biography:

Carolyn Hedley is a Soil Scientist with Landcare Research, a Crown Research Institute, and is based in Palmerston North. Her current research is using digital technology and proximal sensors to monitor and map soil, water and crop during a growing season for improved management and irrigation scheduling.

Carolyn originally trained as a Soil Scientist in England, and has worked in the UK and Canada before settling in New Zealand. Her present goal is to harness new opportunities offered by digital technology to develop improved methods for soil characterization and relate them to resource use efficiency and sustainable farming practices. She is presently studying for her PhD with the Centre for Precision Agriculture at Massey University.

Abstract:

Mapping soil water for precise irrigation scheduling.

C B Hedley[1, 2], I J Yule[1] and M P Tuohy[1]
[1] *New Zealand Centre for Precision Agriculture, Palmerston North, New Zealand*
[2] *Landcare Research, Palmerston North, New Zealand*

World consumption of water is doubling every 20 years – at twice the rate of global population increase. This is largely because worldwide intensification of land use, which has successfully fed the world’s population over the last few decades, has increasingly relied on irrigation. Today 70% of global freshwater extractions are for irrigation, with significant dependency on irrigation for food production in some parts of the world, e.g., 70% of China’s grain crops are irrigated, compared with 25% in New Zealand and 15% in USA. The challenge for the coming decades will be to increase food production with less water. To this end the World Water Council has defined a need to increase water productivity for food production from rain-fed and irrigated agriculture by 30% by 2015 (FAO, 2002).

Our research addresses the need for improved crop use of irrigation water. Such improved use requires an efficient irrigation scheme that can supply exact amounts of water to exact spatial zones. In addition it requires a temporal and spatial knowledge of the soil water content and its plant availability.

Some irrigation schemes, for example flood irrigation, have efficiencies of as little as 40%; in comparison, a well-maintained centre-pivot system has an application efficiency of 90%. Wasted irrigation water can be defined as irrigation water that plays no role in increasing crop growth. This occurs when too much water is applied so that it is lost by drainage or runoff. Conversely, if a soil dries below the point where the plant can no longer take up water at its potential evapotranspiration rate then crop growth will decline and yield will be reduced. The aim of any irrigation scheme should be to maintain the soil moisture content in the active root zone between field capacity and a point where evapotranspiration (E_t) can no longer proceed at the potential rate. This portion of the soil water is called its readily available or plant-available water.

In addition, daily soil wetness was estimated using a water balance approach computed from daily climatic inputs of rainfall and E_t with EC_a-derived soil AWC values. This enables soil water pattern to be modelled and mapped on a daily basis, so that optimal times and amounts of irrigation water can be scheduled for spatially defined zones.

The map defines the spatial variability of the soils with respect to their available water-holding characteristics, and the daily time-step accounts for temporal variations in this pattern due to soil differences. Temporal variations in the soil water pattern occur because of the different drying patterns of soil textural zones, as well as the disuniformity of water applied by the irrigator. These temporal changes in soil water pattern were therefore assessed separately by regressing spatially defined TDR-derived soil water content data points between two sampling dates. Temporal stability had an(during irrigation), suggesting disuniformity of water applied by the irrigator does affect soil water pattern. R^2 of 0.7 (pre-irrigation) and 0.2–0.4

A goal of this research is automated computer control of an irrigation system so real-time spatial information can be uploaded to an irrigator that has GPS guidance. Assuming the system employs an irrigator with a high efficiency rating, automated control that is dependant on spatially defined soil water status and used with individual nozzle control for variable rate water application, would allow optimal use of irrigation water.

FAO. 2002. Deficit Irrigation Practices. *Water Reports 22*. 109p. ISBN 9251-047-685

Session 2: 11.00am – 11.15am.
Dan Bloomer, *Page Bloomer Associates*

Biography:

Dan Bloomer is a principal of Page Bloomer Associates based at the Centre for Land and Water in Hastings. His key activities involve research, extension and training in areas promoting sustainable soil and water management.

The lead author of the 2005 Code for Irrigation Evaluation, he has completed more than 50 on farm irrigation evaluations over the last few years.

Dan is particularly interested in projects that involve farmers, scientists, regulators and other stakeholders working together to develop appropriate technological advances.

Abstract:

Irrigation Performance: findings from system evaluations.

Farmers can improve their production and returns per dollar and per mm of water used by improving the performance of their irrigators, their irrigation management of individual crops or paddocks and their decisions on irrigation priorities

There are applications where precision agriculture principles offer benefits. These often relate to situations where crop water use varies, or different management strategies are desired. Crop water use is a more important factor than soil water holding capacity. In a few cases, a secondary water supply such as from shallow ground water provides significant part of crop need. Variable rate application could be beneficial in this case.

Few farmers appear to optimise irrigation. Current on-farm irrigation efficiency and effectiveness is significantly compromised by system and management quality. Attention to basics has not been adequately addressed in many cases.

This paper irrigation presents results from 50 on-site irrigation system tests completed using the Code of Practice for Irrigation Evaluation 2005. About half the systems evaluated are performing as expected. However, many are not.

Audits have often shown considerable room for improvement, either in the basic design of irrigators, their maintenance, or the way they are operated. Many of these problems can be easily overcome.

Work assessing EM38 and Hydrodynamic surface flow modelling as tools to assess the ultimate destination of applied water at field scale will be presented. While progress has been made, results to date are inconclusive.

Page Bloomer Associates, Hastings. www.pagebloomer.co.nz, dan@pagebloomer.co.nz

Session 2: 11.15am – 11.30am.
Stuart Bradbury, *wheresmycows.com*

Biography:

While studying engineering at Massey University in 2003, Stu Bradbury and George Ricketts set up Wheresmycows.com GPS farm mapping. Upon Graduating in 2005, they registered WMC Technology Ltd to encompass Wheresmycows.com farm mapping and other engineering contract work.
For the past two years, WMC Technology Ltd have been building centre pivot irrigators and mapping farms. Variable Rate Irrigation system is their current major project

Abstract:

Variable Rate Irrigation.

Variable Rate Irrigation involves the delivery of irrigation water in optimum amounts over an entire field. By controlling the amount of water from every individual sprinkler along an irrigator as it moves over a field to match exact water requirements, there is potential for many benefits, including water savings, improved uniformity, reduced runoff, better productivity from crops and livestock, less impact on soil structure, optimised pumping costs and watering speeds.

Session 2: 11.30am – 11.45am.
Sam Trengrove, *Australia*

Biography:

I grew up on a 1000ha grain growing farm on South Australias' Northern Yorke Peninsula. Furthering my education, I studied Ag Science at University Of Adelaide and Graduated in 2005.
I am now employed as a research agronomist by Allan Mayfield Consulting for the past 18 months, and started a part time Masters study at the University of Adelaide on precision weed management in 2007

Abstract:

Increasing the Adoption of PA in Soth Eastern Australia: Experiences and Potential.

SPAA started a project on increasing the adoption of PA in South Eastern Australia in March 2007, with the target farming body being broad acre croppers that had been yield mapping, but were not getting value from their yield maps and had not progressed any further to variable rate application of inputs.

SPAA initiated eight grower groups, seven in the broad cropping regions of South Australia and one in Victoria. The groups have brought together farmers with a varied background in PA, some with up to 10 years experience with yield mapping, others with only one. Over 100 farmers from over 90 farms have attended two group meetings this year and six agronomists have also attended. Of these farmers all use some form of GPS guidance for their spraying operations, all but two or three use some form of GPS guidance for their seeding operations, yet less than 10 growers had used automated variable rate technology, while several others had been changing rates manually in the tractor, according to their knowledge of where rates should change. Most farmers attending have automated variable rate application as a goal, however their time frames for implementation are varied, some wanting to achieve this by seeding next year, whereas others will wait until they can accumulate more data and for seeder and controller upgrades, which may depend on the seasons.

The group environment has allowed the farmers involved to raise issues that they have encountered during their experience with PA, and often-technical issues with yield mapping, GPS and guidance had been solved by other members in their group already. All farmers were surveyed at the initial meeting to ascertain their training needs. Over 50% stated that they would like to be able to clean and process their own spatial data, but all maintained that these processes need to be simple and not require too many office hours.

To make more use of yield maps trials have been conducted by participants in their own paddocks to address their own local issues, including fertiliser rates, seed rates in weed patches and different soil types, manure rates, variety selection, seed dressings, row spacings and tillage equipment. Technical support has been provided by SPAA in conducting these trials. Growers with several years' yield map history have had the opportunity to have their trial paddocks processed, including cleaning, kriging and k-means clustering where relevant. Assessments of trials have been made in season including, where relevant, plant counts, dry matter cuts, N-Sensor scans, plant nutrient tests and soil tests and final yield assessments will be made via the farmers own yield monitors.

The challenge now is to provide the keen growers with the training that they need to be able to handle and manipulate their own data, and also training for agronomists. On most farms

agronomists are now integral in the decision making for many of the inputs that can be applied variably and are likely to be required by growers with lower computer literacy and less desire to spend time processing their own maps.

Acknowledgements
This project has been funded by the Australian Government, Department of Agriculture, Fisheries and Forestry National Landcare Programme and by the South Australian Grain Industry Trust (SAGIT).

Session 2: 11.45am – 12.00pm.
Brett Whelan, James Taylor, Alex McBratney, *Australian Centre For Precision Agriculture, McMillan Bldg A05, University of Sydney, NSW Australia.*
b.whelan@usyd.edu.au

Potential Management Classes: Is there value in their delineation?

Yield mapping in broadacre/row cropping enterprises (using real time yield sensors or remotely sensed yield surrogates such as NDVI) has shown that spatial variation in yield can be typically 2-4 fold in grain crops (Clifford *et al.*, 2006) and up to 10 fold in grapes (Bramley & Hamilton, 2004). Producers are quickly accepting that this production variability has implications for setting yield and quality goals and crop nutrient use.

Australian producers are attempting to understand this variation by matching the yield data with equally intensively observed soil and terrain information. In Australia, it is well understood that the most dominant influences on yield variability (other than climate/rainfall) are the more static soil physical factors such as soil texture, soil structure, and organic matter levels. These are known to indirectly contribute to the moisture storage, cation exchange capacity and nutrient availability of the soil.

Gathering direct data on these attributes at a fine spatial scale is problematic, but a number of correlated attributes can be gathered relatively swiftly. The apparent electrical conductivity of the soil (ECa) has been shown to provide correlation with a number of the deterministic physical soil parameters and to provide corroboration of the spatial yield pattern in many fields. Paddock topography has also been shown to provide an indirect indication of variability in soil water movement and soil physical and chemical attributes - again usually due to a high correlation with a deterministic attribute such as soil texture or depth. Topography information, gathered using sub-decimetre Global Navigation Satellite Systems, also provides indirect information on microclimate attributes that influence crop production potential. Both soil ECa and topography need be gathered only once across the area of interest.

Many Australian broadacre producers now routinely gather yield data using their own or contract harvesters and those with autosteer systems can collect data for the DEM during all navigation operations (tillage, sowing, spraying etc).The soil ECa maps are generally gathered using a local contractor who uses an Electromagnetic Induction (EMI) instrument such as the EM38 or an Electrical Resistivity (ER) instrument such as the Veris 3100.

In some obvious instances these layers can be used directly to formulate management plans. For example, in broadacre irrigated fields the topography can be used to derive cut/fill maps for leveling purposes. In areas of Australia where some of the soil types present are typically low enough in pH to limit crop growth, the application of lime (CaC03) is required every few years. Using the soil ECa to direct soil sampling into regions of differing soil characteristics allows differential lime requirements to be calculated to minimise the quantity and optimise the impact of that which is applied.

However, when there is not an obvious amelioration action evident, the construction of potential management classes (PMC) for further investigation is gathering acceptance. Crop production maps obviously contain information on seasonal production that is essential to this process. Beginning this process without information on the spatial variability in the saleable product would appear to be financially imprudent. In Australia the delineation of PMC is most routinely tackled using multi-temporal remotely sensed imagery (Adams & Maling,

2004) or multivariate analysis combining crop yield, soil ECa and topography/terrain attributes (Whelan & McBratney, 2003)

Including information on soil and landscape variability in the PMC decision process allows these important factors to influence the subsequent sampling and management of a field. Using the variation in the production indicator factors - crop yield, soil ECa and topography/terrain - as a basic data set to delineate areas of homogeneous yield potential has proven successful in a variety of regions in Australia (Whelan & Taylor, 2005). The response of inputs/ameliorants to these factors will of course be site-specific, but the significance of their influence appears not.

At the ACPA we have developed a procedure that has been adopted by farming groups around the nation (Taylor *et al*., in press). In general the process is:

- Measure spatial variability in the paddock production potential (at present best simply described by soil ECa maps, crop yield maps, and digital elevation models)
- Determine number and location of potential management classes using multivariate clustering if the variation is deemed suitable.
- Direct soil/crop sampling and analysis within the management classes to investigate practical causes of variation.
- Interpret test results and instigate remedial action if indicated. If analysis suggests variable-rate nutrient treatment is warranted, rate changes are formulated based on soil test data and crop requirements, replacement theory or within-field experimentation for input response is designed and analysed.

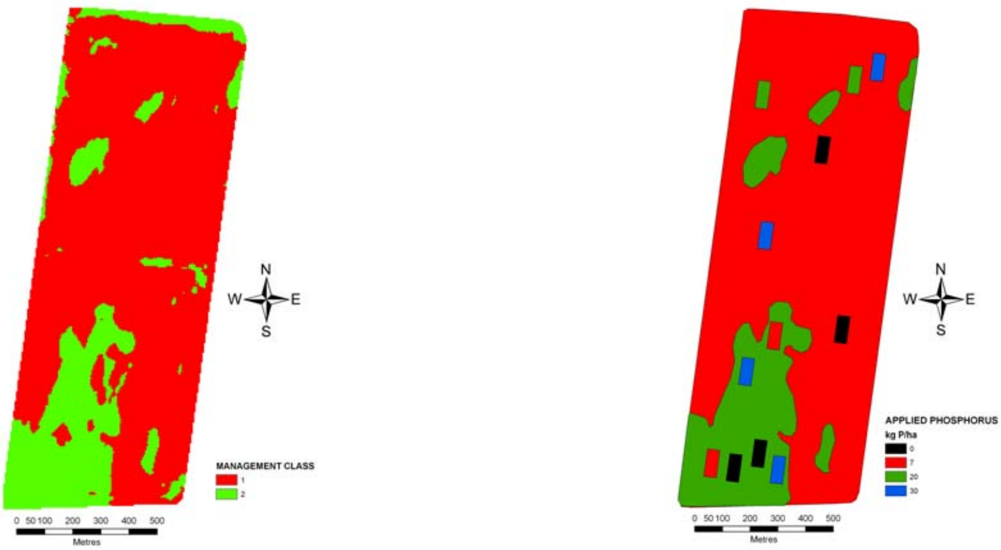
Of course other data layers that may be locally pertinent and gathered at the same spatial scale may be included (e.g. soil depth, gamma radiometrics, product quality).

Variable-Rate Fertiliser Treatments

Two broadacre examples here highlight the usefulness of delineating and exploring a greater understanding of fertiliser response in PMC's.

Road Paddock, Crystal Brook, South Australia

(a) **(b)**

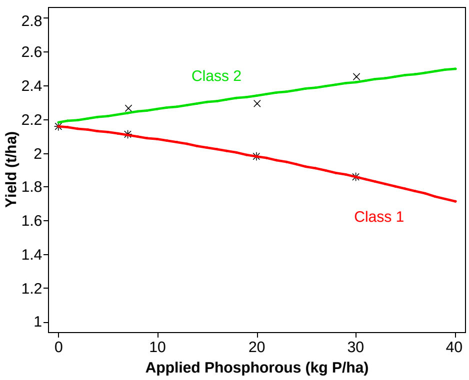


(a) Management classes in Road paddock (b) Fertiliser application map

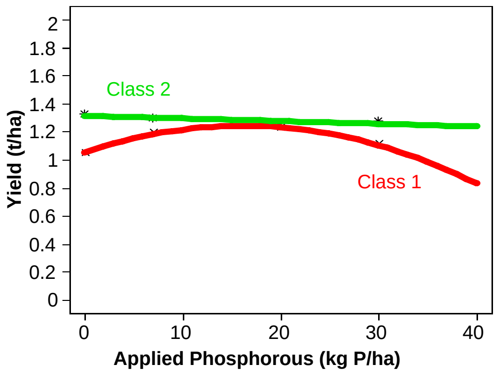
The management classes in Road paddock were constructed from an EM38 soil conductivity map, an elevation map and 2 years yield map data. Subsequent soil testing within these classes highlighted a significant difference in P fertility levels between the 2 classes in 2002 and again in pre-season testing in 2003. The fertiliser rate experiment was established and management decided that from the beginning the overall P application rate to Class 1 would be reduced.

The experiment was designed to be in place for 4 years through the rotation. The yield responses for the 4 years are shown below:

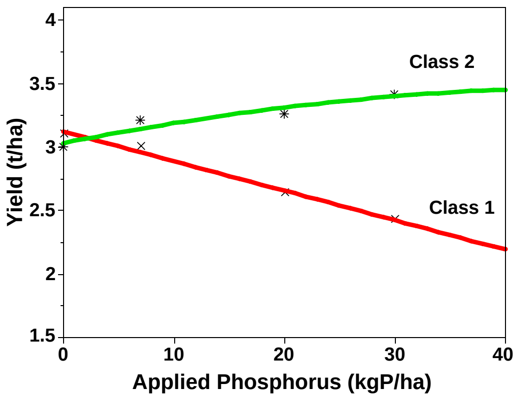
2003 Wheat



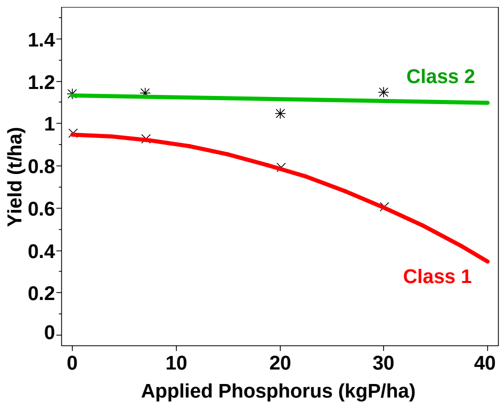
2004 Field Peas



2005 Wheat



2006 Barley



It is obvious that the yield response, especially in the cereals, is far less in Class 1 where higher P levels are applied. The experiments were analysed for the economic waste based on treating this paddock with a uniform application of 11kg P/ha (as was done prior to any PA work). This potential wastage figure is how much has been wasted if we compare fertilizing with a blanket level of P (11kgP/ha) with the optimum required by the field as produced in the experiments.

Year	Crop	Wastage ($/ha)	% fertiliser overapplication
2003	Wheat	35.55	100
2004	Field Peas	8.22	38
2005	Wheat	65.02	78
2006	Barley	33.40	100

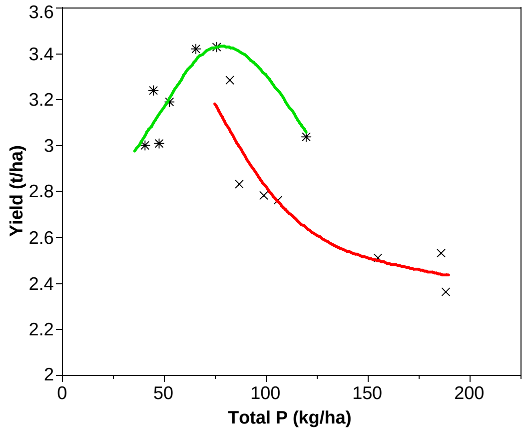
Given that the actual blanket rates on the 2 classes to 7kg and 20kg P/ha were changed at the outset, an analysis of the data with this in mind shows that this simple change has provided a $35/ha increase in income over the 4 seasons (approx $9/ha/yr). The differential fertilisation of the Field Peas was the only year to produce a loss and in all but 2005, a reduction in the rate from 20kg P/ha in Class 2 would have been more profitable.

The differential fertilization that was undertaken has been successful in slowly leveling out the average P concentration across the field as evident in the levels of soil P per year (ppm):

	2002	**2003**	**2004**	**2005**
class 1	57	76	54	48
class2	27	35	28	52

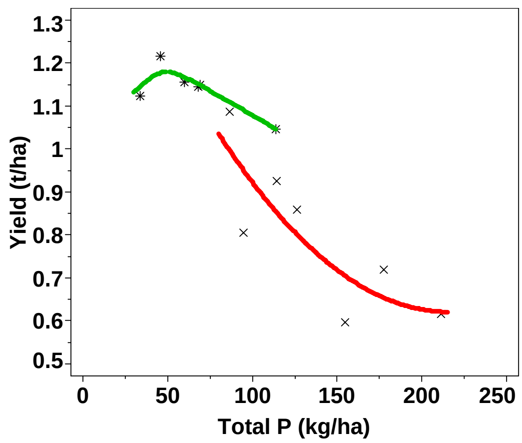
We waited for a couple of years for the soil P levels in the application strips to respond to the fertilser application before measuring the levels in each strip before sowing. Measuring the fertility level in each strip allows us to combine this with the rate which is actually applied and get the apparent amount of soil P that the crop is seeing. The figures below show the results for 2005 and 2006.

(a)



2005 Wheat (Total P = Presow + Applied)

(b)



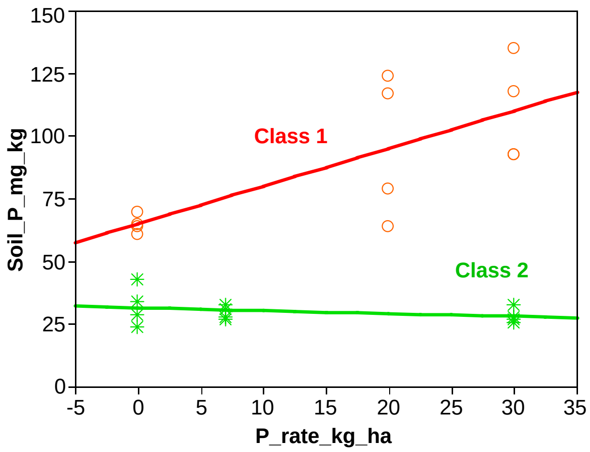
2006 Barley (Total P = Presow + Applied)

Texture & AWC

		CLASS	
Depth	Property	1	2
0-10cm	Clay	37.7	27.7
	Silt	8.9	13.1
	Course Sand	22.5	27.6
	Fine Sand	30.9	31.8
10-30cm	Clay	43.5	35.1
	Silt	6.9	11.2
	Course Sand	18.3	24.8
	Fine Sand	31.3	28.9
30-60cm	Clay	47.6	38.2
	Silt	7.6	12.1
	Course Sand	16.2	21.3
	Fine Sand	28.6	28.4
0-60cm	AWC	68.8	80.3

From the data available it appears that for this paddock a total P load of greater than 80kg/ha may be associated with some economic loss in cereals (more so in Barley), and certainly in class 1. While this does not mean that high P itself is restricting growth, this level is certainly diagnostic of where yield will be restricted.

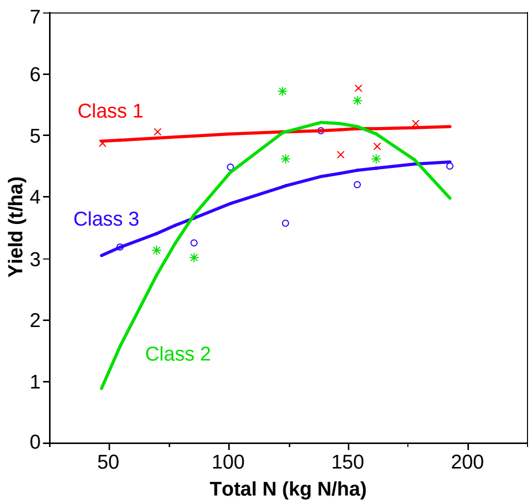
There is an average 14% lower AWC in class 1 that is certainly contributing to the different yield potentials given the relatively flat topography. The graph below shows that where the P strips are being given high rates of P, then the P is building up in class 1 but not in class 2. These results are the combination of 2005 and 2006 soil test data. So, the application of any more than maintenance P to class 1 is economically unwise. A greater reduction than is currently undertaken may be financially beneficial for the next year or 2.



Soil P in test strips according to the treatment rate (2005 & 2006)

Paddock 44, Yarawonga, Victoria.

The same process has been applied here, but N was determined to be the most suitable management option. Wastage over the years from a uniform application of 46kgN/ha has ranged from $23.38 to $38.52/ha. With the strips in position for a number of seasons it is now possible to better quantify the optimal soil N required in each class. In 2005, targeted soil sampling prior to fertiliser application showed that classes 1, 2 and 3 held 101, 78 and 78 kgN/ha respectively. Using the information here, differential treatment to optimise N load in each class would provide a $13.70/ha boost in gross margin in this good season.



Optimum N (kg/ha)

Class 1 = 50
Class 2 = 142
Class 3 = 152

Range of Financial Wastage Across Experiments

From a number of experiments conducted around in SA, VIC and NSW, the figures in Table 1 show that the potential gains from variable-rate fertiliser application range by crop and season, but are not necessarily dictated by paddock size. All this work has highlighted just how site-specific the application and rewards of PA will be, but also just how useful PA tools are at getting to the specific information for each paddock.

Year	Fertiliser	Crop	Size (ha)	Wastage (A$/ha)
2003	P	WHEAT	110	35.55
2005	P	FIELD PEA	110	8.22
2005	P	WHEAT	110	65.02
2006	P	BARLEY	110	33.40
2005	N	BARLEY	50	6.95
2006	N	WHEAT	50	50.61
2003	N	CANOLA	130	23.38
2004	N	WHEAT	130	38.52
2004	N	WHEAT	79	25.27
2004	N	WHEAT	80	15.24

Other Variable-Rate Treatment Options Used In Australia

In implementing differential treatment, many quantity-based operations that influence crop yield are being targeted to achieve desired yield goals. Ideally, the control segment of any variable-rate application should optimise both the economic and environmental product of the field. In Australia the economic considerations are dominant as there is little regulatory control on the chemistry of the agricultural environment. However, most crop producers are well aware that maintaining a healthy environment is important for sustainability and therefore economic success.

Besides traffic, fertiliser and ameliorants, Australian producers are also targeting variable-rate treatment for:

- Harvest (e.g. wine grapes for quality based on management class, wheat and barley for protein based on management class and real-time sensors)
- Sowing rates (e.g. higher cereal rates in previously mapped areas of chemically resistant ryegrass)
- Pesticide application (e.g. real-time plant sensors for application in fallow fields)
- Irrigation water (e.g. block by block vineyard irrigation based on soil ECa and imagery)
- Crop growth regulators (e.g. aerial PIX application in cotton based on vigour imagery)

References

Bramley, R.G.V. and Hamilton, R.P. 2004. Understanding variability in winegrape production systems. 1. Within vineyard variation in yield over several vintages. *Australian Journal of Grape and Wine Research* 10:32-45.

Clifford, D, McBratney, A.B., Taylor, J.A. and Whelan, B.M. (2006). Generalised analysis of spatial variation in yield monitor data. *J.Agric. Science* 144: 45-51.

Taylor, J.A., McBratney, A.B. and Whelan, B.M. (2007). Establishing management classes for broadacre grain production. *Agronomy Journal*. (in press).

Whelan, B.M. and McBratney, A.B. (2003) Definition and interpretation of potential management zones in Australia. In: *'Solutions for a Better Environment' - Proceedings of the 11th Australian Agronomy Conference*, 2-6 February 2003, Geelong, Victoria. Australian Society of Agronomy. CDROM ISBN 0-9750313-0-9. http://www.regional.org.au/au/asa

Whelan, B.M. and Taylor, J.A. (2005). Local response to nitrogen inputs: advancing SSCM within Australia. In: J.V.Stafford (ed) *Precision Agriculture '05, Proceedings of the 5th European Conference on Precision Agriculture, Uppsala, Sweden*, Wageningen Academic Publishers, The Netherlands, pp 865-872.

Session 2: 12.00pm – 12.15pm.

Craig Lobsey, M. Short, J.A. Taylor, B.M. Whelan, R. V. Rossel and A. B. McBratney, *Australian Centre For Precision Agriculture, The Faculty of Agriculture, Food and Natural Resources, The University of Sydney, NSW 2006*

Multi-Sensor platforms.

This presentation provides a brief overview of development of proximal soil sensors at the Australian Centre for Precision Agriculture (ACPA) and their amalgamation with existing soil sensors into a single sensing platform. Proximal Soil Sensing (PSS) refers to sensors that are able to measure soil properties (e.g. soil conductivity) in real-time through either direct contact or at a close range to the soil. These sensors are able to provide rapid, repetitive and on-the-go soil measurements at low cost. As such, they satisfy the temporal and spatial resolution required by precision agriculture.

PSS research at the ACPA falls into two primary areas.

i) the development of a Multi-Sensor Platform (M-SP) so that multiple sensors can be run simultaneously across fields and,

ii) the development of new proximal soil sensors to improve the coverage of useful soil properties.

The M-SP is being developed to incorporate current and future proximal soil sensors with a positioning system enabling real time, low cost, high resolution collection of field soil data. Currently the system consists of various ground conductivity sensors include the Geonics EM38, EM31 and a Veris EC platform. The system also includes the Veris soil pH measurement unit and a Gamma Radiometer (GR320). The platform provides high resolution soil data for use in site-specific crop management and, as a research tool, the system will help to improve understanding of field-scale soil variability. The M-SP also provides a computing base for the development and testing of various online algorithms and soil inference engines being developed by the soil science group at The University of Sydney.

The M-SP is also being designed to accommodate future proximal soil sensors, such as the combined multi-ion and Near-Infrared proximal sensor being developed at the ACPA. There are currently no proximal soil sensors for the direct measurement of soil chemical nutrients such as sodium, potassium and nitrate. This presentation will also briefly outline the preliminary development of sensors intended to fill this technology gap. These sensors make use of Ion Selective Electrode (ISE) technology, and aim to provide fast indications of soil ion concentration through;

1. Modelling the ISE response dynamics and soil ion exchange kinetics.
2. Characterising measurement influences such as temperature, soil moisture, ion interference and variations in the ISE response characteristics.

This approach should provide the robustness and response time required for on-the-go measurements of these properties.

Session 3: 1.30pm – 1.50pm.
Rob Bramley, Kerstin Panten, David Gobbett, *CSIRO Sustainable Ecosystems*

Biography:

Rob "chucker" Bramley has a past association with Massey University, where he studied for his PhD. During that period he played for the infamous Diggers cricket team where according to team captain Mike Tuohy he only ever produced what could best be described as "moderate performances". (That is actual being charitable compared to what was actually said.) Mike also talks about his lack of commitment and passion for the game and desire to win. Clearly Mike can claim to have put Dr Bramley on the straight and narrow as he achieved great things since moving to Australia. Rob Bramley is a Principle Research Scientist with CSIRO and leader of the Land and Water Precision Viticulture Group based in Adelaide.

Abstract:

Optimising Vineyard management through whole-of-block experimentation

Rob Bramley[1] and Kerstin Panten[1,2] and David Gobbett[1]
[1]*CSIRO Sustainable Ecosystems, PMB No. 2, Glen Osmond, SA 5064, Australia.*
[2]*Present address: FAL Institute of Plant Nutrition and Soil Science, Bundesallee 50, 38116 Braunschweig, Germany* Rob.Bramley@csiro.au , Kerstin.Panten@fal.de

"The overall philosophy is to get it right in the vineyard with a healthy and sustainable vine and soil balance to produce sound, flavoursome grapes."

One would imagine that this basic philosophy, which was expressed in a recent *Varietal Report* in the *Australian and New Zealand Wine Industry Journal* (WIJ), underpins the decision making of the majority of viticulturists and vineyard managers in Australia and New Zealand, and for that matter, those elsewhere in the world. However, like other kinds of agricultural fields, vineyards are variable. A number of questions therefore arise, including: How should grapegrowers and their winemaking colleagues go about "getting (sic) it right in the vineyard" so that "healthy and sustainable vine and soil balance" may be achieved ? How will they know when it is ? What are the effects of perturbations to this balance that the winemaker might consider optimizes flavour and aroma outcomes ? Can any of these questions be properly answered without some experimentation and, assuming that the answer is "no", where and how should such experimentation be conducted ? The last of these questions will be the main focus of this presentation.

Depending on the question to be addressed in an agronomic experiment, the utility of traditional plot based approaches may be compromised by the effects of underlying spatial variation. Such approaches also suffer from limitations in terms of how widely results can be extrapolated beyond the experimental area. One solution to both of these problems is to conduct experiments over much larger areas, such as entire fields or management units and to use their variability as an experimental tool. This is not a new idea. Indeed, Simon Cook presented the so-called 'chequerboard experiment' at the first of these symposia held in 1997 – a variable rate N experiment conducted over approximately 70 ha of wheat in Western Australia (Cook et al., 1997). Dean Lanyon then discussed its first application in vineyards at the 2004 symposium using an example from Langhorne Creek (Lanyon and Bramley, 2004). Here, we focus on more recent vineyard experiments and highlight advances in experimental analysis made possible by the recent work of Bishop and Lark (2006). The results demonstrate that by using the whole vineyard as an experimental unit and taking underlying spatial variation into consideration, more information can be gained than would be obtained through using traditional plot-based approaches.

For example, Figure 1 details selected results from an experiment imposed in the inter-rows of a 4.8 ha organic Merlot vineyard in the Clare Valley. The experiment was established in response to concerns that the organic management system may be placing a constraint on vine nutrition resulting in low yield and vine vigour and that the permanent ryegrass cover crop in the mid rows of the vineyard was competing with the vines for both nutrients and water. Thus, the experiment comprised treatments aimed at enhancing vine vigour and yield through promotion of nutrient cycling - ryegrass combined with either undervine compost (RGC; control) or mulch (RGM), or a cereal cover crop sown in alternating rows with a legume in the intervening rows (CL).

Comparison of remotely sensed imagery (Figure 1c) collected at veraison in 2006 with a pre-experiment image (data were normalised to account for seasonal effects) suggests that increases in vine vigour were associated with the CL treatment. Analysis of treatment responses in terms of the components of yield (Table 1) also suggest that the CL treatment delivered the greatest benefit. However, by analysing treatment effects according to

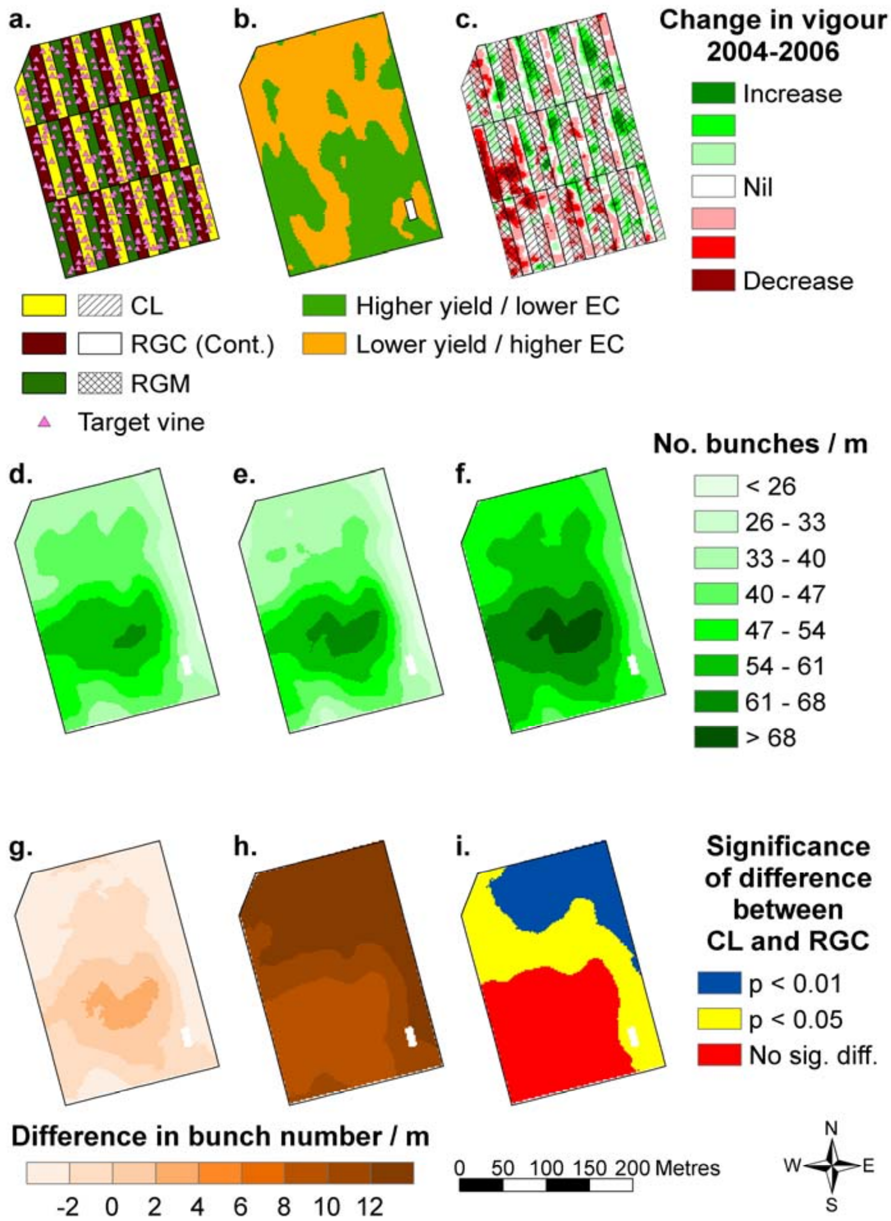


Figure 1. The Clare experiment showing (a) the experimental layout; (b) an indication of the inherent variability in the block derived from *k*-means clustering of a pre-experiment yield map and EM38 soil survey; (c) the difference between normalised values of PCD (IR/R) in images acquired at veraison in 2004 and 2006; bunch numbers per metre in 2006 for (d) the ryegrass and compost (RGC; control), (e) ryegrass and mulch (RGM) and (f) cereal and legume (CL) treatments as well as difference maps for (g) RGM minus control and (h) CL minus control. Map (i) shows the significance of the difference shown in (e) as determined by per pixel tests of significance.

'potential performance class', derived from *k*-means clustering of EM38 soil data and a pre-experiment yield map (Figure 1b), more information was gained (Table 1). For example, the increase in bunch numbers in the CL treatment compared to the RGC and RGM treatments was greater in the lower yielding compared to the higher yielding parts of the block.

Table 1. Treatment averages and ANOVA results of vine performance parameters, 2006

	Treatment			
Variable	RGC	RGM	CL	ANOVA - *p*
Bunch number m^{-1}	45	43	56	***< *0.0001*
Bunch weight [g]	57	63	68	** *0.0024*
Berry weight [g]	0.77	0.82	0.81	*n.s. 0.0819*
Berries/Bunch	71	76	84	***< *0.0001*

Variable	RGC HY	RGC LY	RGM HY	RGM LY	CL HY	CL LY	ANOVA - *p*
Bunch numbers	53	35	49	37	59	54	***< *0.0001*
Bunch weight [g^{-1}]	76	35	77	48	87	60	***< *0.0001*
Berry weight [g^{-1}]	0.87	0.66	0.92	0.71	0.92	0.77	***< *0.0001*
Berries/Bunch	86	53	84	68	96	79	***< *0.0001*

HY = Higher yield / lower EC; LY = Lower yield / higher EC

Whilst knowledge of potential performance class improves assessment of the size of treatment effects, analysis of the data using the method of Bishop and Lark (2006) adds considerably to the utility of the results. This method relies on the assumption that the observed responses to a set of different treatments may be regarded as realizations of spatially auto-correlated and cross-correlated random variables. Through the combined use of linear models of coregionalisation and co-kriging, the responses to different treatments are estimated for any part of the experimental site using the data pertaining to both. This allows the estimation of contrasts between different treatments measured at different locations over regions (Bishop and Lark, 2006). Thus, Figures 1d-i enable the vineyard manager to see that the effects of changes in management will be spatially variable, and thus, the locations where they will be most beneficial and/or not worth pursuing at all. Importantly in this example, they demonstrate that the significance of treatment responses (Figure 1i) is not as well aligned with the performance classes (Figure 1b) as Table 1 suggested, a result which has implications for the current broadacre trend towards zone based experimentation.

References

Bishop, T.F.A. and Lark, R.M. 2006. The geostatistical analysis of experiments at the landscape-scale. *Geoderma* **133**(1-2): 87-106.

Cook, S., Adams, M and Riethmuller, G. 1997. Designing and implementing on-farm experiments in Precision Agriculture. *In:* Proceedings of the 1997 ACPA Symposium on Precision Agriculture Research in Australasia. www.usyd.edu.au/su/agric/acpa/symposiums/conf.htm.

Lanyon, D.M. and Bramley, R.G.V. 2004. Precision Viticulture – a tool for improved vineyard experimentation. *In:* Proceedings of the 8th Annual Symposium on Precision Agriculture Research and Application in Australasia. www.usyd.edu.au/su/agric/acpa/symposiums/PA2004.pdf.

Acknowledgments

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Session 3: 1.50pm – 2.10pm.

Doug King, *Eastern Institute of Technology,* **Caine Thompson, Hayden Lawrence,**
Spatial Solutions, Hawke's Bay

Biography: Caine Thompson

Massey University Graduate

BApplSc (Horticulture)

Post graduate diploma (Horticultural Science)

Professional experience

Vineyards Manager for Alpha Domus Estate Winery in Hawkes' Bay for two years from 2003-2005. Responsible for all aspects of vineyard management for 40 hectares of estate vineyards

Viticulturist/Vineyards Manager for Mission Estate Winery from 2005 until present. Responsible for vineyard management of 50 ha of company owned vineyards and responsible for overseeing and advising of Mission Estate's 20 contract growers

Director of Spatial Solutions – offering NDVI and EM38 mapping services to agricultural/horticultural and viticultural clients

Abstract:

Use of NIR measuring tools to determine harvesting strategies.

It has long been known that variation exists between and within vineyards. Without methods for quantifying this variation, it has been tolerated resulting in inconsistent wines from year to year. The concept of precision viticulture is to manage blocks according to variation. Over time, this variation which has been shown to be temporally stable can potentially be minimised through the application of correct cultural practices. From a vineyard management perspective, the viticulturalist can develop techniques for managing this identified variation. For the winemaker, once variation is identified accurately, then zones can potentially be selectively harvested based on maturity analysis.

Considerable work has been undertaken to quantify variability within blocks using the precision viticulture tools (Normalised Difference Vegetative Index (NDVI) and EM38).

NDVI essentially measures the quantity of photo synthetically active biomass within the crop canopy. This has been used to quantify zonal boundaries and the significance of these to measured vine growth, grape and organoleptic wine quality parameters.

This work presents case study blocks in the Hawke's Bay region of New Zealand where variation in vine vigour existed. Plots of vines were set up at each site representing the range of vigour differences. The influence of these differences was quantified including seasonal phenology, grape ripening, yield, and juice composition, and following micro-vinification, wine quality. At veraison, NDVI measurements were undertaken on the ground surface.

Data from both the Cabernet Sauvignon and Sauvignon Blanc sites showed that vigour variability, as measured by pruning weights and trunk circumference, influenced grape ripening rates, grape yield, bunch numbers, bunch and berry weight, Brix, pH and TA at harvest. While anthocyanin levels were not affected in wine made from the Cabernet Sauvignon grapes, total phenols, tannins and quercetin were reduced by high vigour. High vigour decreased total phenolics in Sauvignon Blanc grapes and increased levels of

methoxypyrazines. The variability in these measured parameters was closely associated with variation in canopy biomass as recorded by the NDVI mapping.

The consequences of the measured vineyard variability on zonal management including harvest decisions, and the benefits accruing from the resulting wine quality are presented. Some successful commercial management decisions made in the 2007 vintage using vegetative crop mapping are given. These are discussed in terms of how wine grape pricing could signal benefits of adoption of the sensor mapping technology.

Session 3: 2.10pm – 2.40pm.

John-Paul Praat, Frank Bollen, *Lincoln Ventures Ltd*

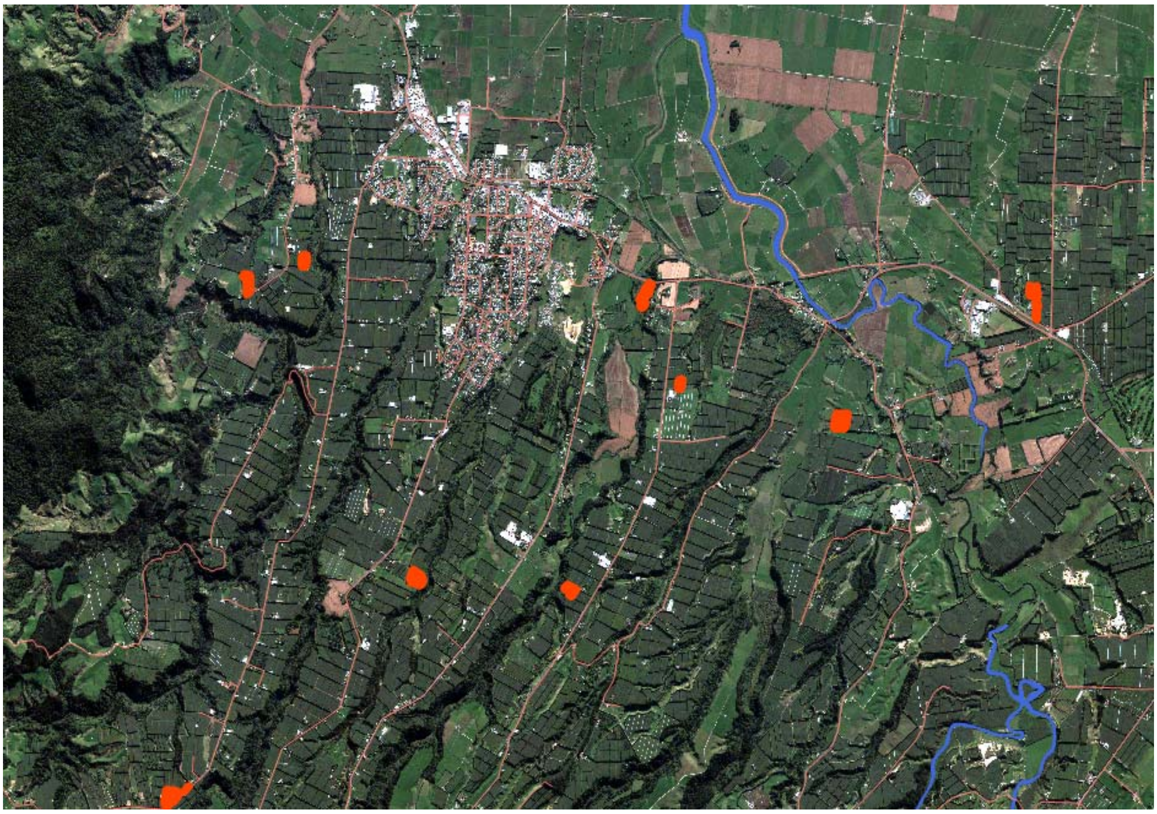
Abstract:

Can the quality of kiwifruit on the vine be predicted by remote sensing?

Modern supply chains require tools and technology to provide market preferred product on time and to required specifications. In the kiwifruit industry this is largely managed by spatially segregating the crop prior harvest into batches of fruit of similar dry matter. There is growing interest in improving the accuracy of spatial segregation to maximise returns. Crop canopy is associated with dry matter accumulation and variation in the canopy could potentially indicate variability in fruit quality. Remote sensing is routinely used in annual crops such as wheat and perennial crops such as grapes to monitor plant health, plant nutrition and soil properties. This study explored the potential to remotely measure the canopy status to identify spatial variation.

Multispectral data from the Quickbird satellite captured at various times during the 05/06 growing season was compared with fruit dry matter sampled at harvest in May 2006. The figure shows an example satellite image and the distribution of test orchards. Multispectral response showed some relationship to fruit dry matter outcomes. However, the response was variety, orchard and timing of image (month) specific, and many orchards showed no useful response.

Distribution of orchards (orange areas) within the satellite footprint (May 2006)



Session 3: 2.40pm – 3.00pm.
Ieda Sanches, Mike Tuohy, *Massey University*

Abstract:

Proximal Sensing the Botanical Composition of New Zealand Pasture.

Ieda Sanches[1], Mike Tuohy[1], Mike Hedley[1] and Alec Mackay[2]
[1] *Massey University, Palmerston North*
[2] *AgResearch, Palmerston North*

Pasture reflectance spectra were obtained *in situ* using an ASD FieldSpec® Pro FR spectroradiometer under artificial illumination provided by the CAPP (CAnopy Probe for Pasture). The objective was to evaluate the possibility of discriminating the components and predicting the botanical composition proportions of New Zealand pasture species using reflectance spectra.

The dataset, consisting of spectral data and pasture samples, was collected between August 2006 and June 2007, at dairy and sheep farms in the North Island of New Zealand. The pasture samples were separated into the main botanical components: grass, legume and weeds, and the percentages of each component were calculated. Partial least squares (PLS) regression and discriminant analysis (DA) were the statistic methods used for analysing the data.

The total sample set (361 samples) was randomly divided into calibration and validation (prediction) data sets, representing 70% and 30% of the samples, respectively. The best result for PLS regression between pre-processed reflectance data (between 420-2468 nm) and grass percentage was an R^2val = 0.72 and an RMSEval = 10.7% (val = validation). For legume percentage the best result was R^2val = 0.62 and an RMSEval = 11.1%; and for weed percentage was an R^2val = 0.41 and an RMSEval = 9.58%. For the grass variable, results for PLS regressions were applied to subsets of the spectrum instead of the full range (420-2468 nm), and comparisons of calibration-validation with cross-validation methods are also presented.

Session 4: 3.15pm – 3.35pm.

Hayden Lawrence, Ian Yule, *NZ Centre for Precision Agriculture*

Abstract:

A vision for Precision Dairying.

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 through 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 economical 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, 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 & 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. This paper describes the development of the *Rapid Pasture Meter*© and combined management software as a PA tool for dairy farmers.

Discussion

Development of the Rapid Pasture Meter©

Traditional methods of pasture measurement suffer from a number of problems, these include: slow pedestrian based systems, limited sampling capability leading to 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:

1. **Tier 1** – simple start/stop measurement with manual recording and input to bundled farm management software.
2. **Tier 2** – record on board, wireless download to bundled farm management software
3. **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 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 and fertiliser treatments. Research trials can now be evaluated on a farm/field scale rather than plot scale.

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 well as within a daily management routine (pre and post grazing measurement) to calculate accurate herd intake information and supplementary feed recommendations.

Future advances of PA technologies for NZ dairy farmers

The NZCPA is also investigating and developing other PA tools and management support systems for the NZ dairy industry including:

4. Pasture quality monitoring
5. Fertiliser tracking and management
6. GPS cattle tracking
7. Remote condition scoring and locomotion

Session 4: 3.35pm – 3.55pm.
Jenny Jago, *Dexcel Ltd*

Biography:

Position: Team Leader, Labour and Technology Group, Dexcel Ltd

Qualifications: BSc, MSc(Tech), PhD

Jenny Jago is the Team Leader of a group focussed on developing solutions for New Zealand dairy farmers in relation to labour and technology. Brought up on a family-owned dairy farm in Taranaki Jenny studied science and technology at Waikato University, gaining her PhD carrying out studies on the behavioural development of bulls and its impact on meat quality before spending 2 years working in research centres in Denmark and France. For the past 6 years she has been devoted to developing New Zealand's first automatic dairy farm at the Dexcel led Greenfield Project in Hamilton and has travelled extensively studying automation within dairy systems around the world.

Abstract:

Automatic Dairy Farming – Fact or Fantasy?

New Zealand dairy farms have undergone rapid expansion over the past decade. The average farm is now 118ha, has 322 cows, produces 106,00kg milk solids and employs 2.4 FTE. Farms are larger, family labour has been replaced with employed staff and fewer people are required to manage more cows. Continued growth is being fuelled by the prospects of record high milk payments. The ability of the industry to attract and retain quality staff in a highly competitive employment climate will be critical for sustained growth. Record high workforce participation and record low unemployment rates in New Zealand are putting pressure on an already tight labour market.

The processing sector of the dairy industry utilises a very high level of automation from milk arrival through to product dispatch. This is in contrast to milk production and harvesting on-farm which remains highly labour intensive. Dexcel leads a research programme that aims to take a technology-led approach to on-farm dairy production. The programme is developing the farm systems to use automation technology to reduce manual labour and information technology to increase output via better decision making. The Greenfield Project forms part of this programme and to date has achieved the automation of milk harvesting through the use of internationally sourced automatic milking systems (AMS) and development of a novel on-farm cow traffic management system. This presentation briefly overviews the labour-related challenges facing the dairy industry and describes the progress towards the development of an automatic dairy farm.

Session 4: 3.55pm – 4.15pm.
Keith Betteridge, *Agresearch Grasslands*

Abstract:

GPS and urine sensors for sheep and cattle to improve nitrogen models and identify critical source areas for targeted mitigation management

Keith Betteridge[1, 4], Des Costall[1], Coby Hoogendoorn[1], Mark Carter[2] and Wendy Griffiths[3]
[1]AgResearch Grasslands, PB 11 008, Palmerston North, New Zealand
[2] 240 Mangaone Rd, RD9, Feilding, New Zealand
[3]AgResearch Invermay, PO Box 50034, Mosgiel, New Zealand
[4] keith.betteridge@agresearch.co.nz

Nitrogen (N) leaching and nitrous oxide and ammonia emissions from urine patches in grazed pastures are a worldwide problem. New Zealand is now starting to implement limitations on N losses from farmland. N discharge allowances are based on nutrient balance models (e.g. Overseer® Nutrient Budget) which, to date, assume all urine return is uniformly distributed across the paddock. In reality urine patches, containing 200 to 1000 kg N/ha, are often concentrated in stock camps and near shelter. Where these urine patches overlap, the potential for N loss increases.

To more accurately estimate N losses in a grazing system, we have developed GPS and urine sensors for female cattle and sheep which log changes in position > 3m from the previous recorded position, and the position of every urination event. Accuracy is ±3 to 5 m. GPS units are mounted on a collar for cattle and on a box held to the fleece on the rump of sheep. The units use six 2700 mAh rechargeable batteries and log data for up five days.

Urine sensors monitor the temperature in a tube placed under the tail. Upon urination the temperature rapidly rises to near body heat and falls to ambient temperature within 10-15 seconds after urine flow stops. The sensor is anchored into the vagina using a modified CIDR. A thermocouple is fitted into the tube outside of the animal. When the animal urinates some of the excreted urine flows through the tube and over the thermocouple. The cattle urine sensor uses a 3.6 V N-type battery and electronic circuitry located within the modified CIDR. The circuitry for the sheep urine sensor is located in a box on the sheep's rump and a sheep-CIDR is used to anchor the tube containing the thermocouple, as in the cattle urine sensor.

The relatively low cost of these units has enabled us to monitor 20 ewes and 20 beef cows concurrently, in 6 to 11 ha hill country pastures, for up to 5 days. Some of these data will be presented.

Supplementary data comprising contour; and pasture mass and quality are to be combined with GPS and urine distribution data to develop a predictive model of where critical source areas of urine patches are located.

These data could be used to: improve nutrient budget models (N leaching and nitrous oxide and ammonia emissions); scale up small-plot trial results to paddock-scale outcomes; and to increase efficacy of mitigation practices by targeting those areas where greatest benefit will be derived.

Session 4: 4.15pm – 4.35pm.
Chris McFadzean, *Farmworks PFS Ltd*

Biography:

Chris McFadzean co founded FarmWorks Ltd in 1995. Since it's inception he has been involved in developing a range of products and services including GPS Mapping, Farm Software development, Pasture measurement devices and Vehicle/Product tracking systems.

After a year's sabbatical in 2006, he has returned to head the Rapid Pasture Sensor and Variable Rate Fertiliser projects within FarmWorks Precision Farming Systems Ltd.

Abstract:

The Rapid Pasture Sensor Capability Study

The Rapid Pasture Sensor Capability Study presented by FarmWorks looks at the directional benefits of using the Sensor to monitor the grass level farm environment.

It demonstrates the benefits to the farmer, the farm consultant and the fertiliser supplier.

It looks at the work required to complete the top tier product in order to commercialise these benefits.