Precision Agriculture (PA) Farming System Research Group - Northern Region

**Summary**

Project Aims

1. Establish a collaborative network of growers currently using or intending to use precision agriculture (PA) technologies and provide a group learning environment for the exchange of PA information and skills, and a conduit for a more rapid transfer of research ideas and technologies.

2. Empower individual growers to conduct on-farm research for the development of a PA farming system for the northern region by providing access to external expertise and technologies.

3. Increase the number of robust PA experiments in the region to provide relevant research outcomes for growers, increase grower adoption of PA and advance the scientific research base.

**Report Disclaimer**

This document has been prepared in good faith on the basis of information available at the date of publication without any independent verification. Grains Research & Development Corporation (GRDC) does not guarantee or warrant the accuracy, reliability, completeness or currency of the information in this publication nor its usefulness in achieving any purpose. Readers are responsible for assessing the relevance and accuracy of the content of this publication. GRDC will not be liable for
any loss, damage, cost or expense incurred or arising by reason of any person using or relying on information in this publication. Products may be identified by proprietary or trade names to help readers identify particular types of products but this is not, and is not intended to be, an endorsement or recommendation of any product or manufacturer referred to. Other products may perform as well or better than those specifically referred to. Check [www.apvma.gov.au](http://www.apvma.gov.au) and select product registrations listed in PUBCRIS for current information relating to product registration.

**Copyright**

Grains Research and Development Corporation. This publication is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced in any form without written permission from the GRDC.

**Old or Archival Reports (Projects that concluded in 2007 or earlier)**

The information contained in these older reports is now several years old, and may have been wholly or partially superseded or built upon in subsequent work funded by GRDC or others. Readers should be aware that more recent research may be more useful for their needs. Findings related to agricultural chemical use are also potentially out of date and are not to be taken as a recommendation for their use.

**Conclusions**

The Northern Region PA Research Group has, throughout trying climatic conditions, provided a vehicle to focus the efforts of the participants and allowed the successful development of a number of techniques that should be applicable to the national cropping community. The preliminary model for the adoption of PA in the northern region can be summarised as:

1. Measure spatial variability (soil electrical conductivity (ECa), elevation, crop yield).
2. Determine number and location of potential management classes.
3. Direct strategic soil and crop sampling and analysis.
4. Interpret test results and instigate remedial action if indicated or design within-paddock experimentation for input response investigation.

The information obtained from the group farms, when combined, has also provided a database for quantifying within-paddock variability in the region. Experimental design and layout have begun, but results have been indicative of seasonal misfortune and conclusions cannot yet be drawn as to the effectiveness of designs or the theory that empirical experimentation on every individual farm will provide the final information for the development of a complete PA decision support system.

**Recommendations**

1. The established farming group should be continued.
2. The management class determination protocol should be tested across the nation through other farming research groups.
3. More data on within-paddock variability need to be gathered around the country to improve development of the Opportunity Index.
4. While remote sensing of cereal crops for yield prediction has been difficult to obtain consistent results, work should continue to determine calibrations between crop parameters and imagery for forecasting, variability and opportunity assessment, supplementing and substitution of proximal sensors.
5. An expansion of experiments across the country would help avoid local climatic restrictions on gaining results.
6. Collaboration and/or initialisation in new crop and soil sensor development for PA should be prioritised to ensure Australian conditions are encompassed in the operational specifications.
7. Approaches for extending the within-paddock assessment to whole farms while minimising data collection costs should be investigated.

**Outcomes**

**Expected Outcome (benefits)**
Economic Outcomes

The output from the project is being directly used by the participating growers in operations. The degree of implementation and use varies with each enterprise and paddock. In general, the outcomes from this project are expected to instigate change in the traditional 'uniform-field' approach to agronomic management. By providing an adoption system to follow, it is expected that the efficiency of input resource use in crop management operations such as fertiliser application, pest control treatments, tillage, sowing and irrigation will be improved. Such changes to the current practices should improve the net variable return. The increase in production information gathered at the 'within-field' scale should also provide a new tool for the assessment of financial risk associated with the above activities.

Environmental Outcomes

Eventually, improved fertiliser placement in line with crop and soil requirements will reduce nutrient wastage. This still remains to be quantified and may certainly take a number of seasons of experimentation on individual paddocks to achieve. Increased use of controlled traffic and vehicle guidance (a side benefit of the equipment and philosophy employed in this project) has been a benefit to reducing the over application of all chemicals through minimisation of overlap.

Social Outcomes

The PA philosophy developed here shows that the grain cropping community is serious about minimising environmental impact and maximising the efficient use of resources and this should improve the interaction between growers and the wider community. On a specific level, the construction of spatial management plans for fertiliser and other inputs shows financial lenders and community regulators that a grower is developing clear management goals. The resulting yield or application maps will show that the strategy is being successful. This should improve the interaction between the rural financial sector and crop growers. Providing a system to begin PA adoption may also entice younger workers into the agricultural sector by offering a new technological career and it may also enhance individual grower understanding and satisfaction in crop production and land management.

Achievements/Benefits

Overview of Project Achievements

Importance

PA aims to identify, measure and provide management options to profitably use within-field spatial variability of field-based factors that affect crop yield and quality. It involves the implementation of advanced information technology and processing as a part of a farm management system. The ultimate goal is to provide and use in-field measurements of production to improve the efficiency and profitability of subsequent crops. Successful implementation will require integration of information acquired through local knowledge, agronomic expertise and experience, and expertise in mapping, spatial analysis and decision support. In Australia, the use of PA is being limited by the difficulties that individual growers are encountering in gathering and integrating these components and skills. This situation has manifested itself in an under-utilisation of available PA data gathering equipment and slow movement from the data gathering phase to implementation of management changes based on gathered data.

Achievements

A network of nine growers who are participating in PA in the northern region has been established and shall continue as part of project SIP09. Despite three winter growing seasons of complications caused by weather conditions in the north, the project has made significant progress towards fulfilling the aims and outcomes listed. The restriction came from the establishment, extraction and extension of results from within-field trials that could not be established or were damaged by weather. Despite testing climatic conditions over the duration of the project, all growers have contributed in some degree to the following achievements (see Attachment for further details and examples):

Determining potential management classes at the within-paddock scale

A system for delineating potential management classes within a paddock has been devised and tested under local conditions. The process involves gathering elevation and terrain information, crop yield and soil ECa data and mapping them onto a single 5m grid across the paddock. A clustering procedure is then employed, and some simple confidence intervals for
yield differences between classes used to determine the number of classes in each paddock. These classes have then been used for stratified soil sampling to cost-effectively examine the causes of observed variability. This achievement has been the basis of the preliminary model for the adoption of PA on northern New South Wales (NSW) farms and has been reported nationally and internationally. The model can be described as:

Gather relevant data layers; spatial prediction onto a single grid using block kriging; k-means clustering using all relevant layers to delineate potential management classes; utilise the field mean kriging variance (yield) to determine the confidence interval (CI) for class partitioning; directed soil and crop sampling to assess soil-related causes of between-class variability (three samples per class); interpret results; ameliorate or establish experiments to determine response to manageable inputs.

Opportunity Index

Progress has been made on the development of a technique for quantifying the potential of a paddock for PA. It is based on the amount and pattern of spatial variability, the operational constraints of sowing and harvesting equipment and the economics of the operations. Yield data, soil ECa and remotely sensed crop imagery have been investigated as the source for assessment. This process is in continuing development and will feed into a revised model for on-farm adoption of PA.

Remote sensing

A number of paddocks have been investigated for local assessment of relationships between airborne in-season imagery and crop yield and soil variability. This has been the least successful area of the group's work, due in part to the impact on cropping imposed by the climate in the past two seasons. Imagery gathered just prior to cereal flowering has shown only a moderate relationship to eventual yield in these seasons. A greater relationship to soil patterns was discovered which is believed to reflect the seasonal limitations. That said, such imagery may hold promise as a surrogate for soil ECa mapping. The group intends to continue exploring this avenue of data gathering with the prospect of helping develop calibrations for use by other growers in the region.

New sensors

A real-time protein and moisture sensor was trialled in the 2001 wheat harvest on one farm. The sensor (mounted on the clean-grain elevator in place of the moisture sensor) worked well, but it was let down by software glitches and some poor environmental sealing. The group was collaborating with a Swedish and US partnership that was keen to test under Australian conditions. Following the Australian tests, a number of significant modifications have been made by the developers and a modified, more robust system (suited to Australian conditions) will be retested on a single farm this 2003 harvest season. This international collaboration on real-time protein sensing is ground breaking for the Australian grains industry.

The group has also been collaborating with the Australian Centre for Precision Agriculture (ACPA) in preliminary calibration of the soil resistivity and conductivity (ECa) sensors that are being employed as part of the quantification of variability on each farm. True calibration is a complex task that has begun with this project and is aimed at providing growers with quantified maps of soil attributes that influence the ECa, not just patterns of ECa itself.

Experimental design for PA

In conjunction with GRDC project US293, the group has been involved in the development of guidelines for experimental design and initial attempts at testing feasibility (see Final Report US293). Climatic conditions have restricted the extent to which experiments have been successfully established and harvested in the group.

Education and extension

All growers have had the opportunity to be involved in the annual PA symposiums held by the ACPA. Here the latest information on PA developments in Australia is available and growers have been able to gain access to other growers around the country, as well as external expertise. The knowledge gained and techniques developed within the group have also been extended within the region (and to other agroclimatic zones) through numerous presentations, workshops and field days.

Additional information

Publications


Practical Definition and Interpretation of Potential Management Zones in Australian Dryland Cropping (2002). Precision Agriculture (PA), 6th Int. Conf. on PA, USA, 15p.


**Attachment**