Developing sustainable farming systems with the aid of precision agriculture tools

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Abstract

Rapid progress comes more often from quantum leaps than incremental steps and precision agriculture (PA) may offer the next leap forward in measuring crop response to management. Spatial technologies such as electro-magnetic surveys, satellite imagery of crop 'vigour' at critical growth stages, and yield mapping may be utilised to increase our understanding of crop response to inherent- (soil type, climate etc) and applied- (agronomy, farming systems etc.) factors. This could facilitate more specific and targeted management, and potentially allow the development of more sustainable and profitable farming systems.

In Victoria's southern Mallee, the Birchip Cropping Group (BCG) is collaborating with 11 innovative farmers who have adopted such spatial technologies to analyse the impact of soil type and crop management on crop growth and yield, with a view to developing more sustainable farming systems. For this group of farmers increasing water use efficiency in order to decrease potential water movement below the crop root zone and into groundwater is a key performance indicator of sustainable farming.

In 2001, the first year of the project, some good correlations between EM38 surveys (soil maps of changing electrical conductivity across the paddock), satellite images of crop vigour at flowering, and crop yield at harvest were found to exist, although this did not occur in all paddocks. Utilising our knowledge of how the crops grew within different zones in paddocks in the 2001 and 2002 seasons, we will develop management plans for each paddock and each zone to improve water use, yields and economic returns.

Key words

Southern Mallee, Birchip Cropping Group, Natural Heritage Trust.

Introduction

The BCG, aided by Natural Heritage Trust funding, is conducting a paddock-scale project monitoring current farming systems in the southern Mallee with a view to developing more sustainable farming systems and reduce groundwater recharge from this region. The farming systems being analysed include conventional fallow/cereal systems, lucerne/cropping phased farming, through to no-till/continuous cropping systems. Within the project the BCG and eleven innovative farm cooperators have taken the opportunity to 'road test' a range of spatial technologies.

Spatial technologies such as electro-magnetic surveys, satellite imagery of crop 'vigour' at critical growth stages and yield mapping are being utilised to:

- determine the spatial variability of crop production within paddocks;
- estimate the amount of water that is not utilised by the crop at grain harvest; and
- support the development of agronomic solutions to increase crop water use and reduce the amount of water bypassing the root system of the crop.

These tools are not being used as stand-alone technologies delivering complete information sets, but rather as tools capable of identifying and measuring differences within paddocks. Once such zones have been identified, these can become the focus for tailored management systems.

Materials and Methods

A field-based research project conducting intensive monitoring of twenty-two paddocks is currently in its second season. The paddocks are located in Victoria's southern Mallee (from Quambatook to Rainbow), lying within the boundaries of the Mallee Catchment.

Across each of the paddocks, an EM38 (electro-magnetic) survey was carried out prior to cropping in 2001 in order to determine any changes in electrical conductivity. Monitoring transects were then established within paddock areas identified by the EM38 survey as having different soil characteristics. Along each transect, soil sampling (including chemical analysis, soil N and soil water status) and detailed crop monitoring (using established TOPCROP procedures) are conducted during the season. Satellite imagery is used to determine crop 'vigour' across the paddock at the flowering stage of the crop.

Paddocks were yield mapped at harvest in 2001. In eight paddocks where yield mapping capabilities were not available, yield was determined along each transect using a portable weigh bin. Grain quality was analysed for each transect.

All inputs and operations are recorded to allow gross margin analysis for each soil type within the paddock. Rainfall is also recorded for each paddock.

Discussion

Precision farming tools can aid in locating problem areas in paddocks and provide a more precise understanding of how different parts of a paddock perform. Agricultural research based on small scale plot work has been valuable in increasing production, but a further step in enhancing production and farm profitability might come from identifying developing practical solutions to suit discrete management zones within paddocks. Such practical solutions may include adjusting inputs or changing crops/varieties to suit variations within soils and between seasons. The outcomes will have to be appropriate to each situation as they apply to individual paddocks and zones within them.

The efficiencies currently achieved by 'across-the-board' management may be superseded be the efficiencies derived from more targeted resource allocation. For example, numerous plot trials and farmer experiences clearly show that in many situations, the application of nitrogenous fertiliser leads to increased yields. From practical experience we also know that the response to N fertiliser over a whole paddock can be highly variable and, even more importantly, we know that N fertiliser is not beneficial every year. Precision farming tools might assist us by identifying those parts of paddocks which are N responsive and where economic returns are likely, and the same tools can also help in identifying those conditions and seasons where responses to investment in N fertiliser are more likely to achieve high returns. This feature of PA technology is facilitating the demise of 'across the board' management that is often ineffective at matching inputs to land capabilities.

The ability to tailor management strategies at the sub-paddock level will undoubtedly lead to the development of farming systems that are characterised by more efficient allocation of resources, greater profitability and sustainability.

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