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LEADING EDGE

Leading Edge, supported by the Society for Engineering in Agriculture and the Australian Centre for Precision Agriculture, provides a local and worldwide window on engineering and PA research.

PA goes digital and remote

By Gary Alcorn

Glenn Fretwell's 5300 hectare family property 'Katandra', is a continuous cropping operation at Newdegate in Western Australia's Great Southern region. The operation relies on advanced agronomic practices to improve sustainability in a fragile landscape.

The farm is located 440 km south-east of Perth in the 350 mm rainfall belt and its soils are mainly shallow sandy gravels to light sandy loams.

"We are very focused on profitability management across all areas of our farm. Through yield mapping we have identified significant variation in yields and in turn profit across the range of soil types within our farming units.

"In a paddock with say a 2.5 tonnes per hectare wheat average we generally have the bottom 20 per cent yielding approximately one tonne per hectare and the top 20 per cent yielding in excess of four tonnes per hectare.

This information had highlighted the need to work with all available technology and processes to understand and manage this variability. There was a large opportunity for improvement of cost of inputs relative to grain outputs, he said.

"Unlike some approaches to precision agriculture (PA) ours has been to maximise profits on each part of every field, rather than attempting to create a uniform yield from one side to the other."

To digitise various physical input data, Glenn yield mapped all crops during the past three harvests.

"We wish we could have started ten years ago. We have purchased crop biomass imagery taken from satellites during late spring in each of the past eight years covering the whole of our farm," Glenn said.

"These crop biomass images correlate

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favourably with on-board yield maps due to our low historical incidence of frost damage.

"As well we have mapped the entire farm for elevation data on a nine metre grid with an accuracy of plus or minus ten centimetres to create a digital elevation map."

The yield maps and, separately, the biomass images are overlaid and analysed to identify areas that are 20 per cent above or below the mean production, as well as defining areas that perform consistently within the same productivity range over the range of years.

These summary or combined images of each field (Figure 1 is an example), provide the basis for further investigation of factors limiting yield and variations to profit.

Glenn says the digital elevation map is useful on its own for contour and drainage planning. But when overlaid with the yield and biomass images it enables the biomass or yield maps to be seen as three-dimensional (3–D) images, further highlighting where each productivity zone fits into the overall landscape. This is particularly helpful during discussions with external advisers not as familiar with the farm.

"Our crop yields seem reasonably consistent with elevation — a reflection of decreasing soil depth, and therefore water holding capacity, as we go higher up our gently undulating slopes. We find similar soil types at similar heights in our landscape, with our lower country generally the best performing soil.

"We have removed all our internal fencing and redundant drainage banks for the purpose of simplifying the controlled traffic layout and improving operating efficiency achieved with longer paddock runs. Where we previously had paddock boundaries generally defined by soil types, we now see PA and VRT as assisting to manage this variation across our now much bigger paddocks," Glenn said.

"We have changed the way we approach our soil sampling as a result of the availability of this information. As distinct from our previous random sampling approach, our soil sample sites are now targeted to productivity zones.

"It might be expected that the soil in the higher yielding zones would show a higher nutritional status and the low productivity zones a lower available nutrition level."

But the opposite seems to be the case. Why? Glenn believes that in the higher productivity zones the crops have been removing a higher than proportionate level of nutrients than the blanket rate applied each year.

"Consequently we are effectively mining the nutrition in those areas. Alternatively, nutrition is accumulating in the low productivity zones due to lower removal rates. This further underlines the importance of being able to vary inputs in relation to production potential and soil nutrition availability," he said.

Identify the limiting factors

With advice from consultant agronomists and nutritional experts, a field-by-field and productivity zone-by-zone mapping project was designed and implemented.

It has produced several results:

• Firstly identifying the factor(s) limiting yield, then;

• Defining an optimum yield for that zone; and finally,

• A profit maximising level of nutrition for that zone and gross margins by yield zone are calculated in a detailed spreadsheet.

"We have varied our application rates of lime, gypsum, nitrogen (N) and potassium (K) for the past three years. As an example, the best 15 per cent of the farm's productivity zones gets double the nitrogen rate of the standard application.

"At the same time the worst yielding seven per cent of the farm is no longer cropped," he said.

Ground and air based assualt

In the coming year Glenn will be involved with a research project designed to explore the use of ground based electro magnetic surveys and airborne radio-metrics with the aim of obtaining better soil type mapping and zone identification.

"We would also like to gain a greater understanding of where we are situated on response curves for N, P, and K at each yield range.

"Our goal for 2004 is to move to electronic automatic variable rate application systems to automatically vary the three fertiliser products applied at sowing time.

"We are going to continue refining our brand of PA while improving profitability and sustainability in a marginal wheat growing region," Glenn said.

FIGURE 1: Average biomass map 1996–2001