

Simplifying precision agriculture

By Roger Lawes, CSIRO

Precision agriculture (PA) has been available to Australian farmers for more than 10 years. In that time, the technology has improved and yield monitors attached to grain harvesters are now common. Variable rate controllers are increasingly more common, and computer processing power has increased to the point that PA can be implemented on a farm, if needed. From a technology availability point of view, there is nothing stopping farmers from adopting PA.

In theory, variable rate application pays because you closely match cropping inputs (fertiliser, herbicide, soil ameliorants) to the yield potential for that portion of the paddock. You only put inputs on where you get a return.

Researchers and extension personnel

from CSIRO, Curtin University, DAFWA, the Liebe group and SEPWA have been exploring the economics of PA in Western Australia as part of a GRDC funded project on the adoption of PA.

As a result of these investigations, they have come up with a series of rules about the economics behind PA which simplify decisions about its adoption.

Rule 1: Precision agriculture pays when the yield difference between two zones is one tonne per hectare or more.

The fertiliser calculators currently used by the industry all calculate the amount of fertiliser needed to grow a crop with a certain potential yield and soil fertility level.

When there is a large difference in yield, the fertiliser rate required to grow a two

tonne per hectare crop and a three tonne per hectare crop differs markedly.

For example on a soil with four kg per hectare of P, the two tonne per hectare crop will require eight kg per hectare of P while the three tonne per hectare part of the paddock will require 12 kg per hectare of P.

Similarly if there was 10 kg N per hectare in the soil, the nitrogen requirement for the two tonne per hectare crop would be 30 kg N while the three tonne crop would require 70 kg N per hectare.

The nutrient response curves – that is the dollar return expected from grain for the dollar invested in fertiliser – are different for a two tonne per hectare crop than a three tonne crop (Figure 1). As a result it pays to put less inputs on the two tonne per hectare crop than the three tonne crop. It is also essential to put enough nutrients on the three tonne per hectare crop to achieve three tonnes.

In contrast if there is only a 0.5 tonne per hectare difference between the zones, the difference in fertiliser rates would be small and the benefit from re-allocating resources from an unproductive or low yielding zone to a high yielding zone is so small as to not be worth it (Figure 2).

For comparison, in a three zone paddock where yields vary by one tonne per hectare, the return from PA is around \$12.40 per hectare, assuming current fertiliser and wheat prices. In a similar three zone paddock, where yields vary by 0.5 tonnes per hectare, the return from PA is around \$2.70 per hectare.

The reasons for this difference become evident when the nutrient response curves



Variable rate application will pay in paddocks with clearly visible soil variations – and therefore significantly different crop yield potential – across the field.

(Photo: Victoria's northern Mallee, CSIRO)

FIGURE 1: The nutrient response curves for nitrogen for a paddock with one tonne per hectare variation in yield between the three zones

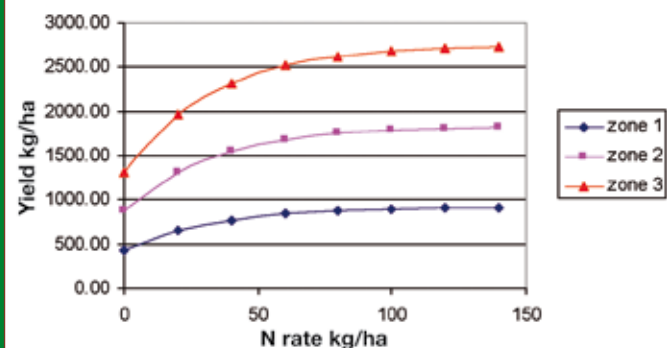
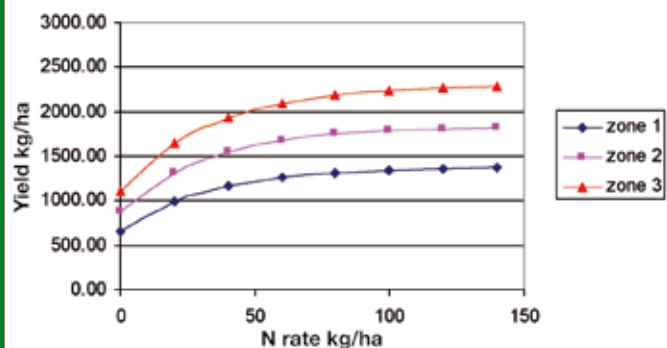


FIGURE 2: The nutrient response curves for nitrogen for a paddock with 0.5 tonne per hectare variation in yield between the three zones



are inspected (Figures 1 and 2). The difference between the curves in the first paddock, with one tonne per hectare yield difference is substantial, and each zone requires a distinctly different fertiliser regime.

In contrast, the nutrient response curves for the second paddock, where yields vary by 0.5 tonnes per hectare are much more closely aligned and the payoff is minimal. It is probably not worth worrying about PA on this paddock.

Rule 2: If soil tests suggest there are substantial differences in nitrogen and phosphorus, PA can pay.

If a paddock has been uniformly fertilised for many years, and one part of the paddock consistently yields poorly, it is likely that fertiliser levels in that part of the paddock can be reduced without economic penalty. Providing the soil pH is not too high (less than 7.5) phosphorus will accumulate in these low yielding areas. The inputs on these low yielding areas can be reduced, thus improving the return in these areas.

In addition, in the high yielding area, there may be less nutrients. This means these areas have been under-fertilised and crop nutrition is restricting yield and therefore reducing overall profit.

Variations in nutrient status often sug-

gest some other constraint is limiting crop yield. For example, soil acidification may limit root penetration and reduce yield.

The net effect might be an accumulation of phosphorus over time. In this situation, PA may pay if ameliorants are applied to the area with high nutrients and low yields. In addition, a previously low performing area may be transformed into a high performing area.

Rule 3: Don't worry too much about how you zone.

Zoning is part of the PA process and with a wealth of information available from yield maps, EM38 surveys or satellite imagery it is tempting to agonise over the shape, size and boundaries of management zones. In reality, year to year variation in yield makes zoning an imprecise science, and for this reason, unless the difference in yield is large (more than one tonne per hectare) and obvious, there is no need to split up the paddock.

Therefore, if you can not tell, with the naked eye, just by looking at the yield map that an area is poor and another area is good where the scale on the map is set at 0.5 tonnes per hectare increments, then there is no need to worry about minor (about 0.2 tonnes per hectare) variations in crop yield.

Zone boundaries should be created using the simplest and easiest tools. This will vary from person to person, but if it works and you are happy with the method, stick to it. There is no right or wrong way. If you create a zone, and it concurs with your view of how the paddock performs – then it is good enough to make management decisions with.

An analysis by CSIRO showed that unless a farmer confused a high performing zone with a low performing zone, the cost of 'getting a zone boundary a bit wrong', in terms of misplaced fertiliser rates was less than \$1 per hectare.

It is extremely unlikely that anyone would confuse a very productive zone with an unproductive zone. In addition, most machinery is so wide, that there is no point obsessing about the precise location of a zone boundary. If it moves by 10 or 20 metres, it doesn't matter, in part because the machinery can not cope with this level of detail anyway.

Rule 4: Not all paddocks need PA.

Not all paddocks have a lot of variation in yield or much variation in soil nutrient status.

These are paddocks that do not require PA, and can be uniformly fertilised. Just ...34▷

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because you have the technology to split a paddock up into zones and manage them differently doesn't mean you should. In a recent economic analysis of a farm in WA CSIRO calculated that PA would return the farm an average of \$8.78 per hectare. But out of 17 paddocks, 12 returned less than the \$8 per hectare more when managed with PA.

The remaining five had enormous variation and returned between \$12 and \$20 per hectare when managed with PA. These were also some of the largest paddocks on the farm. In this situation, the farmer only needs to concentrate on managing the variable paddocks.

Rule 5: If your Variable Rate Technology (VRT) fails, don't wait, put the crop in.

Finally, many farmers have had trouble making the technology talk. Unfortunately, if the technology is performing badly or not at all, put the crop in with a uniform rate. The payoff from PA will be over-ridden by delaying sowing time. It is simply too risky to delay sowing to repair a VRT controller, or fix a software bug that is preventing one controller from 'talking' to another.

It is essential that all the equipment 'bugs' have been sorted out prior to sowing, otherwise something will go wrong at the worst possible time.

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A NEW PA TOOL

To assist with some of the economic decisions around variable rate technology, CSIRO, DAFWA and Curtin University have been developing a PA economic calculator.

This tool calculates the profit derived from a paddock when PA is implemented, compared to managing it uniformly. The calculator takes into account the fertiliser price (for nitrogen and phosphorus), the expected or potential yield of the crop for each zone, the response of the crop to fertiliser in each zone, the area of each zone and the grain price.

All of these factors will influence the return from PA and it is difficult to perform all of these calculations with pen and paper.

This tool will be available for release in February 2010 and is currently being evaluated by consultants in the industry.

PA adoption - small steps are simple enough

By Nigel Metz, SEPWA

Many growers out there may feel more than a little daunted when they first look into precision agriculture (PA). The concept of varying rates of fertiliser or other inputs to a soil types particular requirement over different parts of the farm makes good sense. But putting PA into practice requires significantly different skill sets than previous farming technology adoptions.

Assembling yield and other spatial data, making decisions and creating a zoned prescription map is largely a computer based process, not something you can modify in the workshop. Thanks to the project - "Putting Precision Agriculture on the group in Western Australia" these hurdles are getting easier for growers.

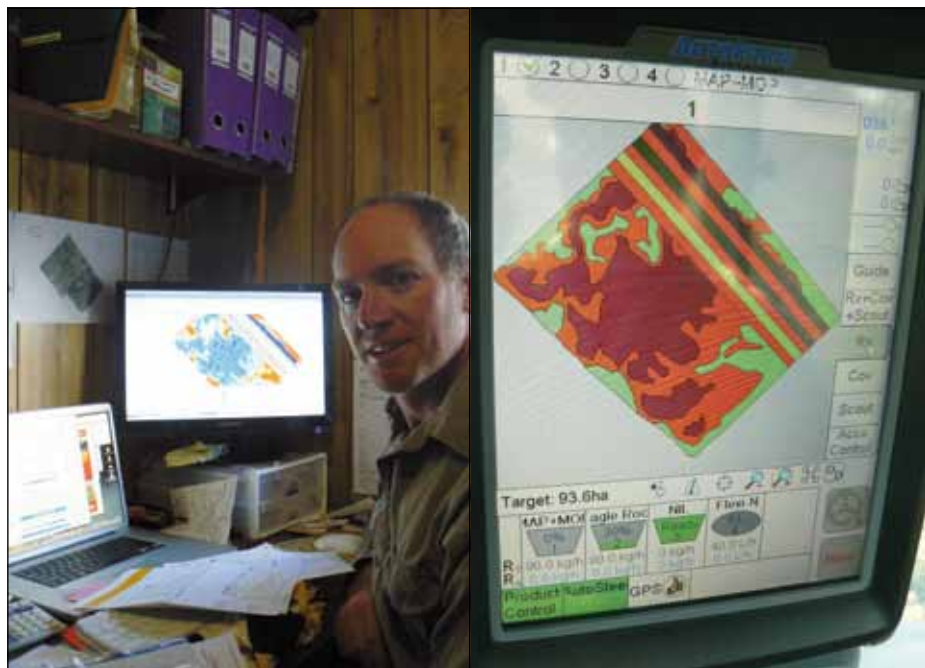
Funded by GRDC this project is lead by CSIRO and is a collaboration between the Department of Agriculture and Food Western Australia (DAFWA), Curtin University and local region farmer groups across the WA. In the Esperance region of WA, the project is collaborating with the South East Premium Wheat Growers Association (SEPWA) to implement PA trials with a number of case study farmers.

In the process of implementing PA trials during 2009, the project needed to progress through the basic steps of making a zoned prescription map for use in PA. This involved:

- Assembling information of the paddocks variability and yield;
- Defining zones within the paddock by which will be managed differently;
- Create a zone prescription map by which inputs were varied across designated zones (in this case it was the variation of fertiliser); and,
- Loading the prescription map into the tractor-mounted variable rate controller for application at seeding, checking rates and zones corresponded accordingly.

The first process of PA is defining the different areas of the farm or paddock in question and deciding how these can be best managed. This is no doubt one of the most confounding parts of PA. Different farmers and agronomists will have different approaches to management across various zones.

To date there are several information sources being commonly used in defining



LEFT: Project participant Colin Degruessa, with his zone map on the desk top computer ready for exporting as shape file to his seeding tractor monitor. RIGHT: The same file loaded, and ready on the tractor monitor.