Variable rate nitrogen: making dollars and sense

Key findings

- In 2011 optimised variable rate N applications increased gross margins by $11-$22/ha in two barley crops.
- In 2012 variable rate N applications increased gross margins by $13-$20/ha in three wheat crops, based on yield response and fertiliser savings.
- Increases in grain protein of 0.3 – 0.5% have been observed.

Why do the trial?

To assess the economic benefit of variable rate nitrogen application, when combined with crop sensor information and yield potential zones to build the variable rate application map.

How was it done?

There are a number of different data layers available that provide information on paddock variability. Information from crop sensors is useful, because it provides a snapshot of how the crop is performing in the current season (Figure 1). This information can be used to produce variable rate application maps for nitrogen (N). However, this assumes that all variability observed is due to variability in N availability, and that the whole paddock has the same yield target. However, we know that this is often not true.

Variability in crop growth can be caused by other constraining factors, and historical yield data tells us that there are usually different yield potentials in zones across paddocks (Figure 2). So, how can we account for this?

In this paddock at Hart N rich strips have been put out across the paddock zones (Figure 3). The N rich strips were put out as UAN with a 2m boom after the crop was sown. The rate was 180L/ha. The N rich strip is important for indicating whether the crop is responsive to N or not and provide a reference for the rest of the crop, this is termed the response index (RI). The response index (RI) is calculated from referencing the N rich NDVI against the adjacent paddock NDVI. Interpretation of N rich strips is explained in Table 1. This paddock is a good example, where low NDVI (Figure 1) in zones 2 & 3 (Figure 2) have different levels of N response (Figure 3). Zone 3 has other constraints limiting crop growth, so whilst having low NDVI, the N response is lower than that observed in low NDVI regions of zone 2.

These three data layers were combined to produce an N application map (Figure 4). The variable rate map recognises that there are zones of differing yield potential, but also that there is variation within the zones, as picked up by the crop sensors. This N application map was applied on August 22nd, the average application being 35kg Urea/ha. To test this theory, constant rate strips of 70kg Urea/ha were applied across the paddock for comparison, as highly replicated strips. These were harvested with a yield mapping equipped harvester to assess the benefit of variable rate application (VR) over constant rate. This method was used in three wheat crops in 2012 at Hart, Bute and Marrabel. The rate calculations at Bute resulted in 20kg Urea/ha more being applied to the VR treatment compared with the growers constant of 100kg Urea/ha, while at Marrabel both treatments received the same rate of urea.

Results

There were no yield differences observed between VR and constant treatment at Hart. However 35kg Urea/ha less was used in the VR treatment resulting in a gross margin benefit of $20/ha. The results for Marrabel and Bute found that on average this method of variable rate N application resulted in a 60 and 80kg/ha yield increase, respectively. This is equivalent to $13-$18/ha benefit when the extra urea is costed in for the Bute trial. This is not a uniform response across these paddocks. Yield maps were generated for the variable rate nitrogen (VRN) treatment (Figure 5) and the uniform treatment (Figure 6). The yield map resulting from uniform N was then subtracted from the yield map resulting from VRN, to generate the difference map (Figure 7).

Similar numbers were generated for barley in 2011, with optimal VRN applications returning $11-22/ha more than uniform N applications.

Earlier work found that protein increases of 0.3-0.5% can be observed in response to VRN applications compared with uniform rate applications. Where grade spreads such as APW wheat are based on 1% protein increments, this equates to a 30-50% chance of increasing the grade achieved for that crop.

These results illustrate that when it comes to varying nitrogen rates you cannot have your cake and eat it too. Variable rate will either distribute the same or more fertiliser to achieve more yield than current uniform practice in N responsive sites, or can result in an input saving, but no increase in yield, at non responsive sites. To achieve large yield gains from VRN implies that current management practice is under fertilising large areas of a paddock. Generally, farmers are currently selecting blanket fertiliser rates that maximise yield potential across the majority of the paddock, possibly 80% or more of the paddock. Consequently, that only leaves about 20% of the paddock to achieve increased yield when supplied with increased fertiliser rates.

So when considering using variable rate in-crop nitrogen it is worth recognising where the economic benefits are likely to be realised. If you under fertilise the majority of the paddock then substantial yield gains may be achieved, but if you maximise yield across most of the paddock you are looking for cost savings where the crop is over fertilised. The only instance where fertiliser savings and yield gains can be achieved at the same location is when over fertilisation leads to haying off and reduced yields. Therefore, establishing the proportion of crop that will be nitrogen responsive and the degree of responsiveness is useful. This information will support decisions on whether nitrogen should or should not be applied and at what rate. It can then support decisions about varying rates and the likely economic benefit in different zones, be they input saving or yield maximisation depending on current uniform applications.

Table 1. Interpretation of N response observed in the N rich strip compare with normal crop growth (non N rich).

	Low N response	**High N response**
Low crop vigour	Indicates the lack of vigour is due to a constraint other than nitrogen. Suggest a tissue test to determine if any other nutrients are limiting or soil testing to ascertain what the constraints are.	Indicates the lack of vigour is due to N and higher rates of N should be applied to these crops or areas of crop.
High crop vigour	Indicates that crop is not responsive to N at the time of assessment but the crop is in good health. Continue to monitor these sites, as it may become responsive later in the season as it depletes soil N reserves.	Indicates crop is responsive to N. Given the good growth of the paddock managed crop assess soil moisture availability before applying more N, as the crop may have grown enough bulk to maximise yield without additional N.

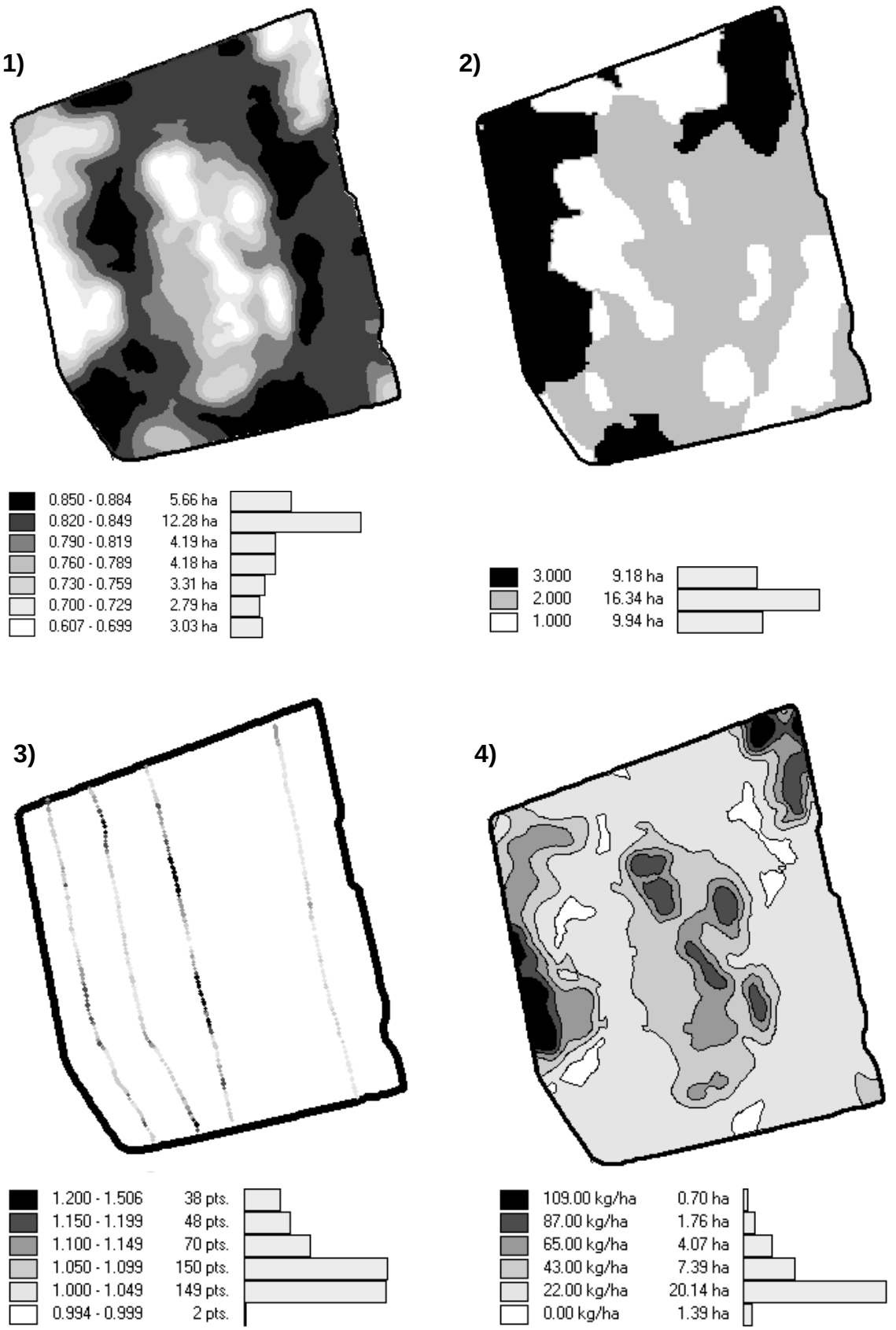

Figure 1) Greenseeker NDVI measured on August 7th 2012 at Hart, 2) Zone map based on historical yield and EM38 data, 3) Response Index (RI) calculated from the Greenseeker

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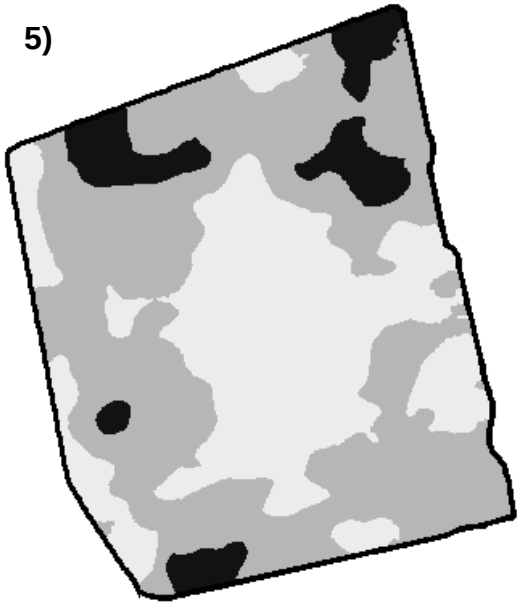

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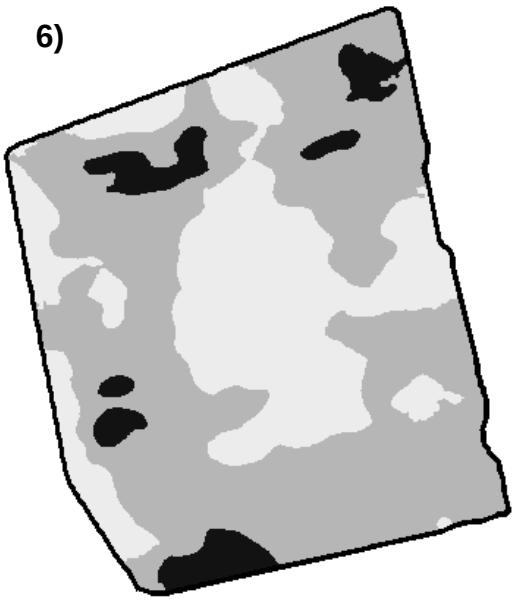

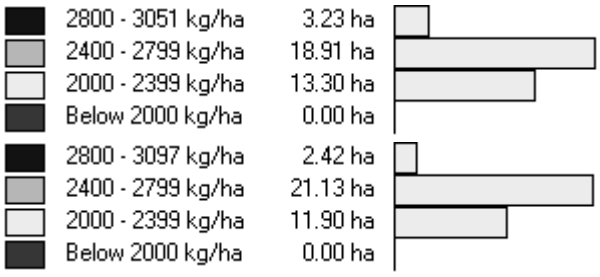

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Figure 5) Hart paddock yield with VRN treatment, 6) Hart paddock yield with uniform N treatment, 7) Hart paddock yield difference between VRN and uniform treatment. On average there is no yield difference, but 35 kg urea/ha less was used on the VRN treatment.