How many paddocks does PA deliver a return on?

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Key Messages

Variable rate technologies and precision agriculture can generate returns of around 10-$15/ha. However, not all paddocks generate these returns. CSIRO, Curtin University and DAFWA have jointly developed an economic calculator to help consultants and farmers decide which paddocks may warrant investment in VRT or PA. On one farm in Bodallin, 9 paddocks out of 20 generated returns of more than $15/ha or more when managed with VRT. Therefore some paddocks benefit from PA and VRT, but many do not.

The dominant factors that dictated whether a paddock was likely to generate a high return if managed with VRT were i) Variable starting levels of soil fertility across the paddock, ii) Large (> 1t/ha) differences in yield between the highest and lowest performing zones. Fertiliser price marginally influenced the return derived from using PA or VRT. The decision to implement VRT on a paddock will vary from farmer to farmer. Some will decide to chase a few dollars / ha, but others may only want to target fields that generate large returns.

Introduction

Precision agriculture (PA), and variable rate technology (VRT) can help farmers produce as much grain as possible from a given quantity of fertiliser inputs. Robertson et al (2008) found VRT could return around $15/ha on a wheat field. However, these returns varied markedly from paddock to paddock and in general Robertson found that VRT generated high returns when crop yields with in the field varied by 1 t/ha or more. In addition, if the starting levels of soil nutrients varied substantially (eg 10-20 kg of N) and (5-10kg of P) then this could influence the returns derived from VRT as much as yield variation. When large numbers of fields were investigated for PA, it was clear that farmers needed to understand how much yield variation they had in a paddock and what the starting levels of soil nutrients were in those paddocks.

From the fields surveyed by Robertson et al 2008, it was clear that not all paddocks needed PA. The paddocks previously surveyed came from different farms on different soil types. For a farmer, the question is which paddocks and how many are likely to benefit from the implementation of VRT? If the benefits are high, the farmer may be inclined to invest the time and energy to make VRT work on these high return paddocks. If the returns are low, then on many paddocks it may only be worth implementing VRT if it is easy and relatively cheap. Individual farmers have different attitudes to VRT, where some will be willing to adopt it across the entire farm, regardless of the return, and others will only implement it on particular fields where there is an obvious economic return. To explore this issue we have developed a PA economic calculator for the industry to address questions about the likely return that VRT can deliver to an individual field. This calculator builds on earlier models defined by Robertson et al 2009.

In this paper we evaluate the likely economic return that VRT can deliver to every cropped field for one farm in Bodallin. We run sensitivity analysis using different starting levels of soil fertility with

different fertiliser prices to determine what proportion of the farm will benefit from a VRT strategy given different price and starting soil nutrient levels.

Methods

The PA calculator, as implemented in MS Exel[tm], was used to evaluate the likely economic benefit from implementing VRT across a multiple paddocks (Figure 1). Details of the calculator can be found in Lawes and Robertson 2011. Briefly, the calculator requires a potential yield, starting level of N and P in the soil, and area in hectares for each zone. The grain price and fertiliser price are also required. For each field we took a yield map from a representative season (2008) and zoned it into 1 (uniform management), 2 then 3 zones. For each of the zones a potential yield was calculated using the yield map. We repeated this process on 20 paddocks cropped to cereals (wheat or barley) in 2008 on a single farm in Bodallin.

For each field, four scenarios were explored where fertiliser price (2 scenarios) and starting levels of soil fertility (2 scenarios). The wheat prices was $300/t. Fertiliser prices varied from moderate ($1.50 /kg / N and $3 /kg/ P) to high ($2.00 / kg/N and $4.00/kg/P). Starting levels of soil nutrients were assumed to be either uniform across the paddock or negatively correlated to yield, where high yielding parts of the paddock were assumed to have less nutrients than low yielding parts of the paddock. See Lawes and Robertson 2011 for more details.

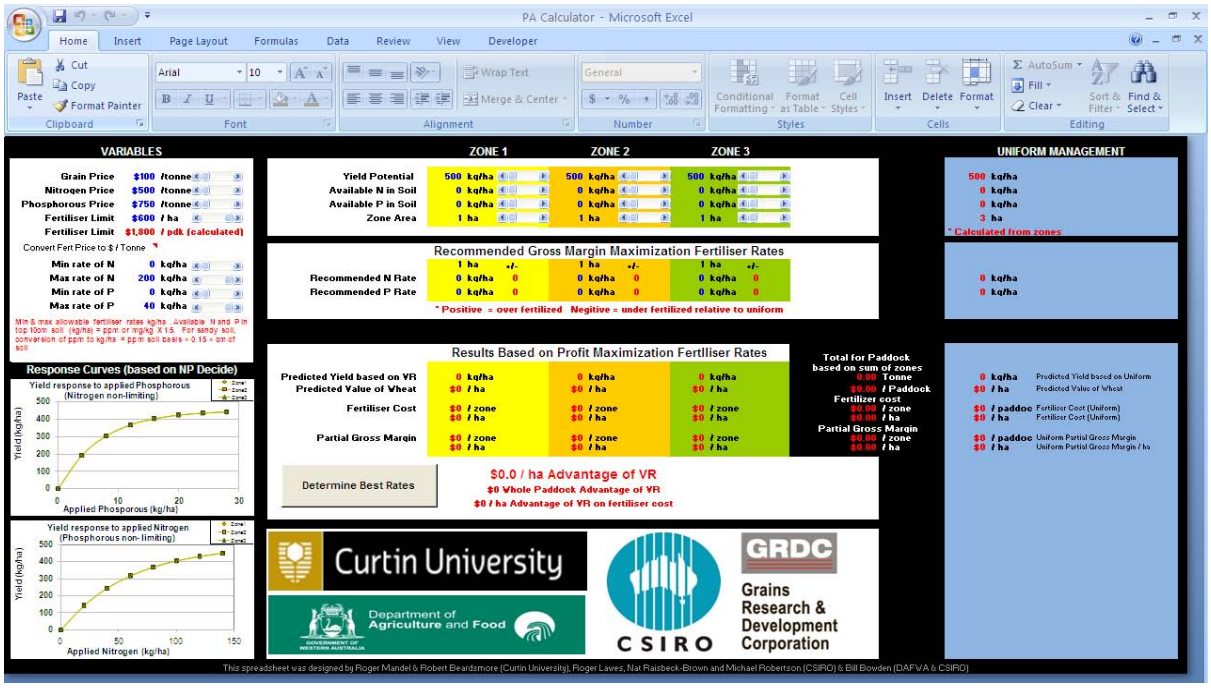

Figure 1. The interface for the PA calculator, that calculates the economic benefit of PA given starting levels of N and P, potential grain yield in each zone, fertiliser price and grain price.

Results

Mean yields from the 20 paddocks ranged from 1.1 t/ha to 3 t/ha. These paddocks varied in size, with 3 small paddocks (< 10 ha), 13 paddocks were more than 100ha and of these five were more than 200ha. When all these paddocks were split into two zones, the yield difference between the zones ranged from 0.52 t/ha to 1.3 t/ha. Therefore the amount of yield variation within each paddock varied considerably across the farm.

The economic return derived from VRT was primarily influenced by two factors. Firstly, returns were generally higher when the difference in yield between the zones was large. For example when crop yields were negatively correlated with starting soil fertility, and the yield difference between zones was more than 1 t/ha, then the return from managing the field with VRT, compared to managing it uniformly exceeded $10/ha on all but one paddock (Figure 2).

Secondly, returns were higher if there was a negative relationship between the starting levels of soil nutrient levels and crop yield (Figure 2). The average gain from using VRT over uniform management when soil fertility was uniform across the paddock was just $2.40. This increased to $12.35 if the starting levels of soil fertility were negatively correlated with yield, therefore returns from VRT are maximised when there is variation in yield and variation in the soil nutrient status.

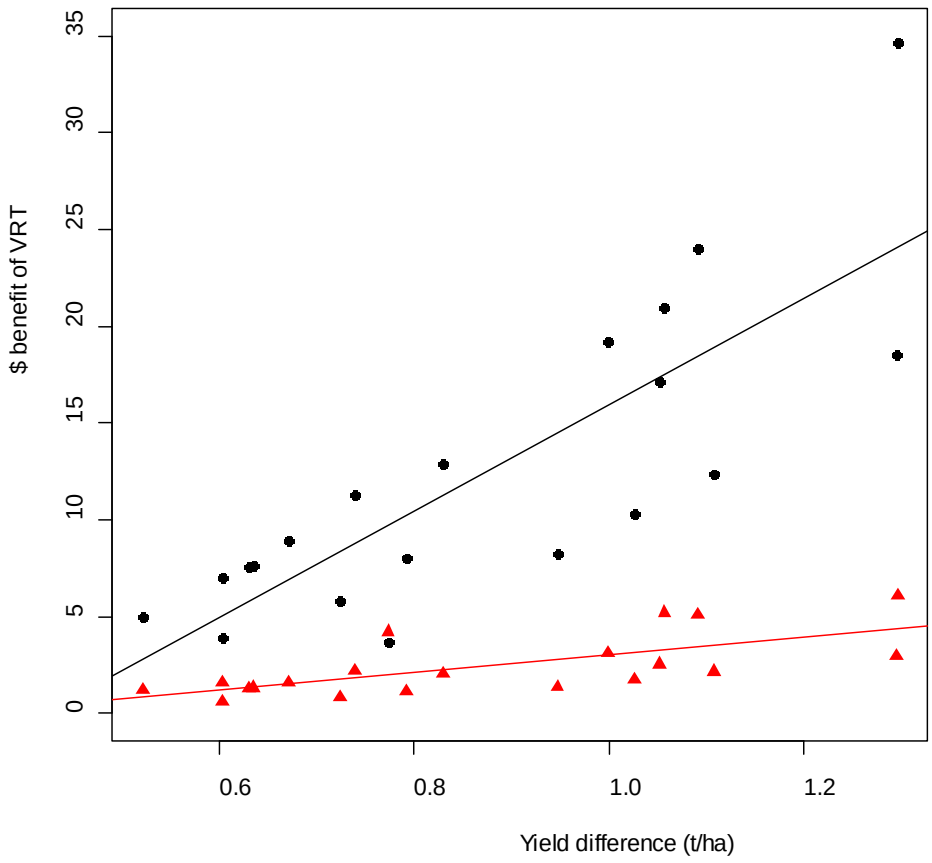

Figure 2. The relationship between the difference in crop yield between two zones in a paddock and the additional economic return derived from managing a paddock with VRT on those two zones compared to uniform management where the starting levels of soil nutrients were uniform (red), or negatively correlated with crop yield (black).

Perhaps surprisingly, fertiliser price had a comparatively small effect on the economic benefit associated with using VRT. When fertiliser prices were low (3.00kg/P and $1.5/kg N), paddocks managed with two zones generated an additional return of $2.40/ha, assuming starting levels of soil fertility were uniform. This increased to $3.37/ha when fertiliser prices increased to 2.00/kg N and 4.00 kg/P. With low fertiliser prices, and when the starting levels of soil fertility were negatively correlated with yield, paddocks managed with VRT in two zones generated an additional $12.35/ha over uniform management. This increased to $15.15/ha when fertiliser prices were high. Importantly,

fertiliser prices did alter the relative rank of paddocks, where those that generated the highest returns when managed with VRT under low fertiliser prices, also generated the highest returns when fertiliser prices were high. This occurred when the analysis was conducted assuming uniform levels of starting levels of soil nutrients and it occurred when we assumed soil nutrient levels were negatively correlated with yield.

How Many Paddock Benefit from VRT?

If starting levels of soil fertility were negatively correlated with yield, 15 out of 20 paddocks generated returns of more than $10/ ha. Of these 9 generated more than $15/ha and 5 generated returns more than $20/ha.

However, if the starting levels of soil fertility were uniform across the paddock then no paddocks generated a return of more than $10/ha and only 3 generated a return of more than $5/ha when managed with VRT. Unfortunately, this complicates the decision to implement VRT because it is difficult to determine what action should be taken without some understanding of the starting levels of soil fertility. This farmer actually decided to implement VRT across the whole farm, even though some of the returns were low.

Growers and advisers should be aware of the size of the returns that a VRT programme is likely to generate, on a paddock by paddock basis, to help clients decide whether to invest valuable resources in surveys and extensive soil testing.

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