MAKING MONEY OUT OF ZONAL MANAGEMENT

A report from the GRDC funded project

'Zonal Management in the Riverine Plains'

Key messages

- Zones can be initially delineated (boundaries mapped) by using EM38 surveys.
- Check zones from EM38 surveys using other tools which include yield maps, paddock elevation maps and historical (farmer) knowledge.
- Once zones are delineated soil test in zones.
- Use soil test decisions to write input prescriptions.
- Deep Soil Nitrogen (DSN) and crop monitor in zones.
- Test strips are a good approach to testing the profitability of variable rates.
- Yield map! Yield map! Yield map!

Introduction

Riverine Plains Inc, has previously identified variation in important soil parameters within paddocks. Other workers in Australia have already developed a means by which this information can be brought together with yield maps and other spatial data to delineate management zones within paddocks. However, most farmers are yet to adopt this technique on a commercial scale. Consequently, a project was designed to delineate and ground truth management zones in paddocks in the Riverine Plains and then investigate options to manage these zones more appropriately, according to their own unique characteristics.

Paddocks at three sites across the Riverine Plains were elected as project paddocks. Broadly speaking the sites are at Yarrawonga, Vic ("Grand View" - Inchbold), Burrumbuttock, NSW ("Yaralla" – I'Anson) and Urana, NSW ("Bogandillan" - Hamilton).

Formalizing Soil Variability

2003 was the first year of this project. In general terms, information that already existed on the project paddocks were combined with an updated EM 38 survey to delineate potential management zones within each paddock. An extensive array of measurements was taken in each zone. In 2003, ground truthing undertaken in each zone included 0-10 cm soil tests, 0-60 cm deep soil nitrogen (DSN) tests, data from in crop monitoring (tiller counts and yields), and soil moisture data using Gopher meters. This ground truthing continued in 2004 and 2005.

In 2004, an effort was made to physically survey the characteristics of the soil across several of the project paddocks at Yarrawonga. The surveyed evaluated the soil monitoring sites already existing in the projected paddocks using all of the known systems of classification including Isbell, Northcote and Great Soil Groups. This survey yielded some very interesting results.

Essentially the properties of the topsoil remained similar across much of the area surveyed, however the properties of the sub-soil changed significantly as the soil surveyor moved down the slope from the tops of the hills through the mid slope to the points of lowest elevation. The sub-soil characteristics of greatest interest for analysis are considered to be:

1. The presence of sodicity in the profile where soil aggregates disperse;
2. Soil permeability.

On the tops of the hills, the topsoil basically overlaid a mix of B/C horizon (partially broken down parent material) with no A2 horizon present. Moving down the slope, an A2 horizon became present (named a 'chromosol' under the Isbell soil classification system), and then more pronounced. As this was happening the sub-soil became more clayey, and eventually became sodic ('sodosol' (Isbell)).

The extent of this variation is highly significant when thinking of the actual characteristics that vary in the soil through these different soil classifications. Many of these properties potentially have a marked influence on production, giving rise to the potential to target different levels of production on these different soil types. An understanding of how these vary across the paddock will provide a key to identifying when and where the crop runs out of available soil water in drier seasons, and where areas of superior drainage benefit in wetter seasons.

Test Strips – A Common Theme

Nitrogen

In 2003, the amount of available N from DSN tests taken from 90 sample sites ranged from 31 to 320 kg N/ha. Statistical analysis of data (analysis of variance) indicated that significant difference occurred between the zones, with no significant difference in values occurring between replications ($P<0.05$). This indicated that DSN values were consistent within each zone, and therefore differences in the DSN status between zones were meaningful.

As a result of the significant DSN results, an N fertilizer response experiment was set out, according to the guidelines developed by the ACPA (Australian Centre for Precision Agriculture). This involved the laying out of a replicated N rate trial in each zone to determine the response of each zone to varying rates of N (Figure 1a). Yield maps (Figure 1b) were used to evaluate crop performance across the zones and also to determine the yield results of the test strips. Analysis of the yield response in each zone to applied urea in 2003 performed by Brett Whelan, ACPA, is shown in Figure 2.

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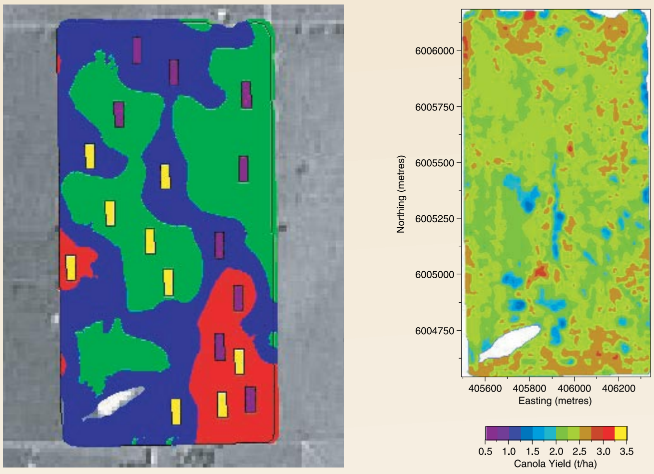

Figure 1. (a) Urea fertiliser application layout – yellow plots received 0 kg/ha, purple plots received 200 kg/ha, rest of the paddock received 100 kg/ha. (b) Canola yield map for 2003.

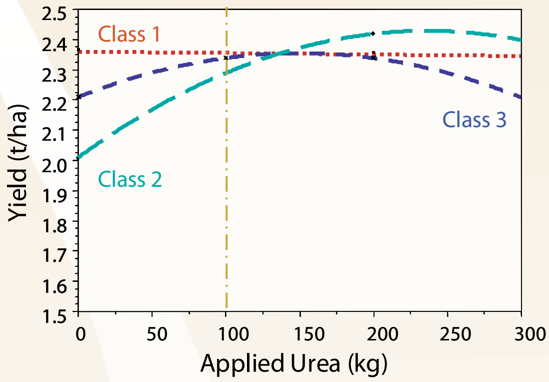

Figure 2. Yield response to applied urea in each potential management class. The paddock average of 100 kg/ha is shown to provide a relatively even yield across the classes, which is confirmed by the yield map.

The yield map is generally uniform across the paddock and this is reflected in the response function analysis. The majority of the paddock received 100kg/ha and the variation between the zones at this rate was calculated to be just 0.1 t/ha on average. However, an economic examination of the response data shows that the output from the different zones would have been optimised by applying different average rates in each. The urea rate for maximum yield and economic optimum urea rate for each zone using a marginal rate analysis is shown in Table 1.

Table 1: Urea rates to achieve maximum yield and economic optimum per management class.

	Urea Rate for Maximum Returns (kg/ha)	Urea Rate for Maximum Yield (kg/ha)
Class 1 (Red – High EM)	0	0
Class 2 (Green – Low EM)	169	237
Class 3 (Blue – Medium EM)	72	151

Using these response functions it is possible to make a simple estimate of what gains or losses in gross margin would have been made if this information had been used to formulate fertiliser decisions at the beginning of the season. Table 2 documents a comparison with the paddock average treatment of 100 kg Urea/ha.

Table 2: Analysis of gross margin losses from fertilising at 100 kg/ha paddock average

Fertilizer Waste	ha x kg = t	x $400/t =$
Class 1	18 x 100 = 1.8	720
Class 3	59 x 18 = 1.06	424
Yield Loss		x $400/t =$
Class 2	53 x 100 = 5.3	2120
Total Loss		3264 (25.10/ha)

As can be seen in the breakdown, in 77ha of the paddock there was more fertiliser used than required, and in 53ha of the paddock an extra application of 69 kg/ha would have brought in over 5 tonne more canola. The total loss in this scenario is $3264 or $25.10 per hectare.

If this information was used at the beginning of the season, the 2.86 tonne of extra urea applied in Class 1 and 3 would have been distributed to Class 2, which would still require an additional 0.8 tonne of urea to be purchased for Class 2. The cost of the extra fertiliser would have been $320 for a gain of $2120 in yield. The difference of $1800 ($13.85/ha) in gross margin would have been gained.

The true result for the 2003 season then (in gross margin terms) is that with this information at the beginning of the season, instead of essentially costing $25.10/ha more for the return it achieved, the paddock could have improved its gross margin by $13.85/ha. The total turnaround in gross margin is therefore potentially $38.95/ha.

In 2004, similar DSN results were observed between zones. This was encouraging as a relatively even yield map had been observed in 2003, giving support to the concept that genuine differences in N status between zones existed. Varying rates of N were applied to a wheat crop in paddock 44 in the same test strips that were used in 2003, to continue to test the varying production potential of the different zones. Figure 3 shows the N response functions for the three zones produced from the yield map of the wheat crop in 2004.

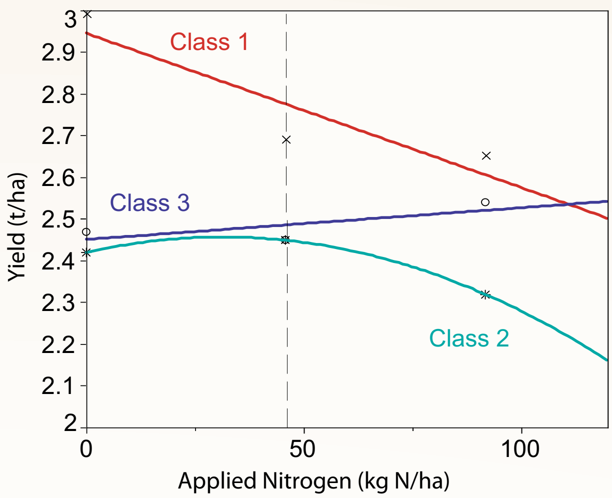

Figure 3. N response functions from wheat crop grown in 2004

2004 had an extremely dry finish to the growing season. Not surprisingly, the high conductivity zone, with its still high N status exhibited a strongly negative correlation to extra N. Extra N in the low conductivity, with its low water holding capacity also reduced yield.

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The N response functions for 2005 are shown in Figure 4. 2005 was a much more favourable year. It can be seen that the response functions resemble to a degree those seen in 2003. The low conductivity zone with its poorer soil continues to respond to extra N when there are regular additions to its moisture profile, i.e. in a favourable season. The medium zone with its intermediate N statues also responds to extra N, but the response curve tends to flatten out. The high conductivity zone, with its higher N status, responds the least to N.

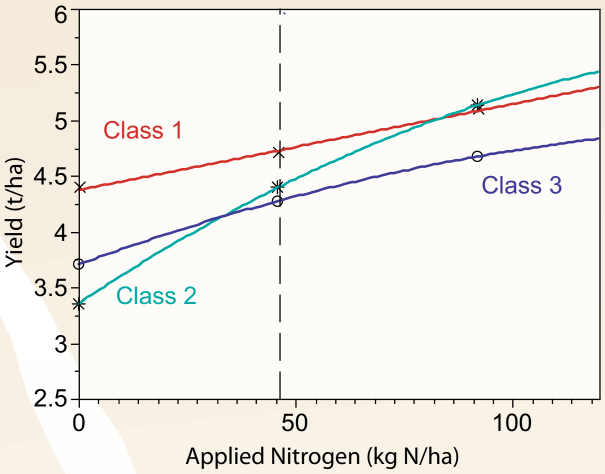

Figure 4. N response functions for 2005 barley crop.

Phosphorous

In a similar fashion to paddock 44, test strips were also laid out in zones in paddocks 46 and 49. These strips however have had varying rates on P applied to them in 2004 and 2005. Figure 5 shows P response functions for the 2005 wheat crop in paddock 46. The key aspect here is the significantly different response to extra P in the high conductivity zone (Class 1) compared to the other two zones.

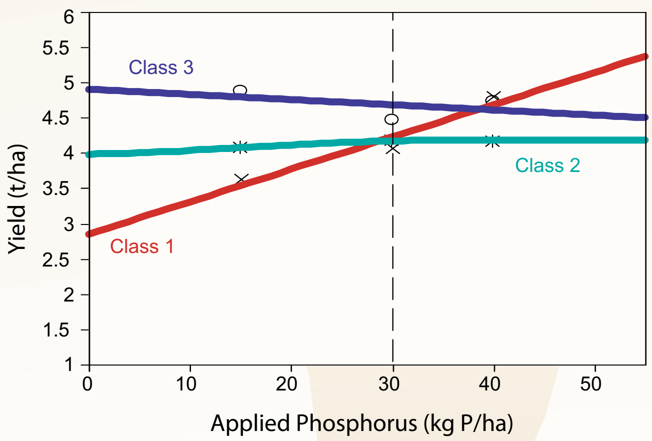

Figure 5. P response functions for three zones in paddock 46.

Soil-Water, One Of The Drivers?

Soil moisture tubes are located within management zones at "Yaralla", Burrumbuttock, and "Grand View", Yarrawonga. At each site, at least three moisture tubes are located in each management zone to provide some replication of results. In 2003, 2004 and 2005 soil moisture was measured at 10cm intervals down the soil profile with a moisture measurement sensor down to 1 metre. Readings were taken during the growing season twice weekly.

The soil-water measurements that are being taken are proving to be a highly valuable dataset. It can be seen that the soils in the different zones have vastly different soil-water profiles. This is obviously crucial for a zones ability to yield, and hence the picture that will develop from further measurements in this area will give more insight into an individual zones' ability to yield.

The above is also supported by the results from the test strips. In the end, the test strips in each zone give an indication of the production potential of that particular zone. For example, in a favourable year, the low conductivity zone has the potential to perform as well as the high conductivity zone. However, when moisture is more limiting, the low conductivity zone will generally yield the lowest. The high conductivity zone seems to have the highest inherent potential to yield, as it can store more water.

Results from the N strips in 2005, have been added to DSN results for these strips prior to N application and graphed against yield to give a yield response to total available N for each of the three zones. The difference in response curves between zones is marked, supporting the notion that there is a significant difference in yield potential between zones (Figure 6).

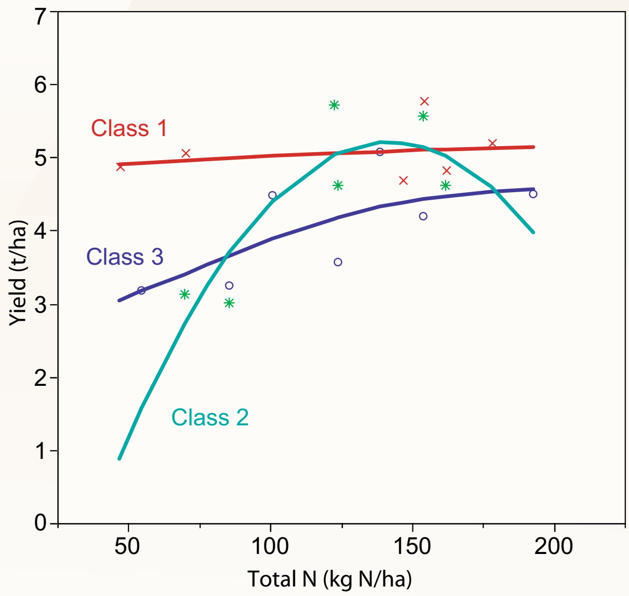

Figure 6. Difference in response curves between zones.

This is an area that represents the next step in zonal management. If farmers know which zones have a higher production capability, then different yield targets can be allocated to different zones, resulting in a more sophisticated and more appropriate fertiliser strategy. However, it is important to remember that a very sophisticated variable rate fertiliser strategy requires very good knowledge of a particular paddocks characteristics and variability to guard against costly errors. This knowledge will be built up over time. At this stage, it would seem that there are a number of simpler steps that should

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be taken by farmers getting into zonal management that don't necessarily require such a comprehensive understanding of their paddocks eg variable rate lime and gypsum applications.

How much money is in variable rate?

Not surprisingly, the answer to this question is dependant on the characteristics of each particular paddock. However, it can be seen from these examples, that paddocks do vary significantly in important production parameters, and that treating these zones differently can result in an improved gross margin. In this project we have seen the potential to make money through variable rate applications of Lime, Gypsum and Nitrogen. Furthermore, a highly complex approach is not required to undertake variable rate applications. Firstly paddocks are split into two or three zones, and then these zones are simply tested as if they were individual paddocks, instead of testing across the whole paddock as an average. Inputs are then applied to individual zones according to their particular test results to achieve a more optimum level of input for the system as a whole. A generic protocol to get farmers started in variable rate has been established by the project team.

The Generic Protocol for adopting Variable Rate Technology is as follows

- Electromagnetic (EM38) survey of the paddock.
- Check EM survey and zones against yield maps, and NDVI (vegetation index) maps, etc.
- Ground truth – topsoil and subsoil cores; presence of rock or gravel, depth to B Horizon, colour changes, compacted layers or plough pans, presence of plant roots.
- Zone paddock/s (decide the number of zones after survey and ground truthing).
- Develop VR lime, gypsum, P and/or N plots (+/-, standard rates, adjusted rates, need for strips or control).
- DSN test of zones.
- Crop monitoring of zones.
- Yield map.

Extending the message

Aside from the extension of results from this project through general information days, Riverine Plains Inc are extending results from this project to farmers through a series of discussion groups that will give farmers that chance to hear about results from this project, as well as discuss and learn about other PA related issues. Over forty farmers have signed up to be a part of this group from the general membership base. In 2005, Riverine Plains Inc gave the members of the discussion group the opportunity to lay down their own on-farm trial plots to assist in the adoption of zonal management on the commercial scale. This will continue along with other PA issues such as guidance and controllers also being discussed and evaluated.

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