Eyre Peninsula Farming Systems

3 Project – Responsive Farming Systems

Now in its final year, the five year (2008-2013) GRDC funded project ‘Eyre Peninsula Farming Systems 3 – Responsive Farming Systems’ continued to study the opportunities to tailor inputs to get the most profitable outcomes under a range of conditions. There has been a key research site at the Minnipa Agricultural Centre supported by regional sites at Mudamuckla and Wharminda on red sandy loam, grey calcareous loamy sand and siliceous sand over sodic clay respectively.

We combined the latest soil and plant science with new machinery technology. The sites have been EM38 mapped, yield mapped and variable rate technology is used for sowing and fertiliser applications. We ground-truthed the modelling tool Yield Prophet® to see if this program will be a benefit in making better farming decisions in the future on upper EP.

At the Minnipa Agricultural Centre, the key research site, the 5 years of the project has seen a wide range of growing season rainfall conditions. Very low, high, above average and average and finally, in 2012 a pasture phase, an above average winter but very low spring rainfall. After 4 years the major outcome was the level of residual phosphorus and total soil N available to maintain crop and pasture production. In studying the opportunities to tailor inputs to maximise profits, at the completion of the 4 year wheat-wheat-wheat barley-rotation, there were examples of no yield difference, on heavier clay based soils, in the 2011 barley, and 3 previous wheat crops, between no applied and applied P and N over that period. This outcome was been repeated at regional focus sites over 3 years. However there are examples of responses to increased fertiliser on specific zones at the regional sites in 2012. The header yield monitor at Minnipa has also measured a yield benefit from targeting in-crop fertilisers to the more productive zones in the average and above average rainfall seasons over the term of the study. These outcomes continue to support tailoring inputs to specific needs, not a historical recipe.

The following series of articles are from trials undertaken in 2012 on the three focus sites or funded via the EPFS 3 project:

• Zone responses to four years of repeated low, medium and high input treatments at Minnipa
• Can we predict the rundown and long term value of P?
• Replacement P in cropping systems on upper EP
• Measuring the effect of residual P
• Time of sowing impacts at Mudamuckla
• Responsive farming for soil type at Mudamuckla
• Trace elements in a fluid fertiliser system at Mudamuckla
• Manganese response in barley at Wharminda
• Phosphorus rate trials at Wharminda
• Managing inputs to soil type in EP farming systems at Minnipa
• Liquid fertiliser evaluation trial

An ‘exit survey’ will be conducted with farmers in early 2013 to determine whether we have met the GRDC target of increasing water use efficiency by 10% on upper Eyre Peninsula.
Zone responses to four years of repeated low, medium and high input treatments at Minnipa

Ben Jones¹, Cathy Paterson² and Roy Latta² and Therese McBeath³
¹Mallee Focus, ²SARDI Minnipa Agricultural Centre, ³CSIRO Ecosystem Sciences

Key messages

- There are identifiable production zones in Paddock N1.
- Production zones are useful for designing sowing input strategies for ‘typical’ yields.
- In wet years, zones still indicate the risk and size of a return to in-season inputs but there will be increased input demand (e.g. N) and the response probably won’t follow the exact pattern of response for an average year.

Why do the trial?

Variable rate technology (VRT) allows farmers to easily adjust sowing and fertiliser rates during the seeding process, providing the opportunity to change inputs according to the production capability of different paddock zones or soil types. While this system has been steadily adopted in other regions it is not yet apparent whether the VRT approach will markedly shift yields and profitability from the levels achieved using blanket inputs across the whole paddock in the Minnipa region.

In 2012 this data was analysed using spatial techniques to address the following questions:

1. In which parts of the paddock was there a difference in crop response to input level?
2. Are the zones of crop response to input level stable or do they change with season type?

What happened?

2008 was a dry season and we see this in the lack of response to varying input levels from low to medium (Figure 1a) except a small response in the Northern part of the paddock. In 2009, GSR was above average and the better production areas in the North East of the paddock showed responses to the medium input treatment (Figure 1b) with some differences between the medium and high input treatments in the North East (not shown). The GSR in 2010 was even better than 2009 and most of the paddock showed responses to medium inputs (Figure 1c) with further responses between medium and high levels of inputs in the North and South East (not shown).
Figure 1. Visual representation of response to medium inputs compared to low inputs in a) 2008, b) 2009, c) 2010 and d) 2011.

Differences between treatments (t/ha):
2011 was an average GSR and the better producing areas did not show responses to increasing inputs above the low input treatment (Figure 1d), however we did observe a response to inputs in the poor producing central parts of the paddock. These treatments will show cumulative effects because the same input level was applied to the same seeder run in each season. The response in the poor producing central part of the paddock is driven by a demand for P input following two high yielding seasons with low P inputs. This is supported by the observation of P responses in 2011 in the P replacement trial located in the same part of the paddock (EPFS Summary 2011, pp 119-122).

**What does this mean?**
There were responses to differing levels of inputs in different parts of the paddock. The paddock area that responded to inputs depended on both season type and treatment history (eg. poor part of paddock responded to inputs only after 2 above average GSR seasons). The pattern of response to inputs in the landscape may be correlated with soil type after a period of dry years, but will be affected by nutrient removal and paddock history after wetter years.

Zone-based upfront input strategies should focus on ensuring nutrition is adequate for the minimum likely yield. In wetter years, input requirements may not follow zone boundaries, but yield potential will. The status of the crop should be used as a guide to where to place in-season inputs, but zones will indicate the likely risk and size of the response.

**Acknowledgements**
We acknowledge the funding from GRDC project UA00107 for this work. Special thanks to Brett McEvoy, Mark Klante and Trent Brace for their assistance sowing and managing the trial.
Time of sowing impacts at Mudamuckla

Peter Kuhlmann
Farmer, Mudamuckla

Key messages
- Strategic dry or early sowing is a good option for a portion of the cropping program.
- At Mudamuckla an average yield loss of 10.2 kg/ha/day occurs between the first wheat crop sown and subsequent crops in the program. This represents 71 kg/ha per week or a yield penalty of 11% per week in an environment with 1 t/ha average yields.

Why write the article?
Early sown/early emerging crops are often the best yielding crops on upper Eyre Peninsula (EP) and early/dry sowing is now considered for an increasing area on my farm annually. Analysis of actual 2006 – 2012 time of sowing data from my program at Mudamuckla shows that sowing early can create a better balance between soil water content available to crops and pastures, and the peak water demand of the crop.

The soil type used to generate the information is typical of the calcareous soils of low rainfall areas of western EP with high boron, high pH, high evaporation, and only rare years where subsoil moisture can be conserved in summer and autumn in sufficient quantity for crop use the following spring.

The Yield Prophet® Sowing Opportunity Report from the Mudamuckla Focus Paddock (Figure 1) shows the peak potential yield for Mace wheat should result from sowing around the end of April. The frost risk increases as you sow earlier (minimal risk at Mudamuckla compared to that of a dry spring or hot conditions at anthesis or during grain fill) and the risk of heat shock increases sharply after sowing in June.

In this environment rainfall is typically received in small amounts throughout the year with falls over 20 mm rare in one event. Small amounts of rainfall are prone to rapid evaporation in the September to April period. The monthly rainfall peaks in July, but the peak demand from the crop is in August and September. The evaporation is large because of the low latitude of my district, and is at its lowest in June.

Figure 1 Sowing date impact on yield of Mace wheat and associated frost and heat shock risk taken from a Sowing Opportunity Report generated in Yield Prophet for the Mudamuckla Focus Paddock, 2012
The graph takes into account the variety, the specific soil type, pre-season soil moisture, the weather conditions and unlimited nitrogen.
In an average year scenario (seeding in early May) the crop has sufficient moisture to grow a reasonable amount of biomass up until August when the crop runs up into head (Figure 2). The daily requirements for both transpiration and evaporation are then rising rapidly, as is the risk of yield limiting heat stress (Figure 3). Water to satisfy grain fill to achieve the potential set earlier in the year needs to come from timely spring rains or stored soil moisture, neither of which are reliable at Mudamuckla.

**Important practices and considerations for early sowing at Mudamuckla**

Sowing later maturing varieties first is a way of matching the season length with the attributes of the variety. In seeking an early, competitive crop, water is often used up too early leaving little for flowering and grain fill. “Managing canopies” of early sown crops may assist the partitioning of soil moisture for later in the season when crop demand outstrips rainfall.

Observations of practices that can increase water stress in dry springs are high nitrogen status soils, high fluid phosphorus and nitrogen rates, high seeding rates, grazing crops (delays maturity) and cultivation. These practices all work well in years with adequate spring rainfall.

Cereals have great plasticity in their growth and can compensate for variations in plant density in the absence of constraints such as weeds or diseases. However, they are less able to compete with weeds if sowing rates are reduced, so paddock selection is critical.

Early sowing a paddock repeatedly is likely to select for a grass population that consists mostly of later germinating plant types. It is important to mix up the sowing order of paddocks over the life of a rotation. Dry sowing can produce good yields as early emerging crops compete well with low grass numbers. Later maturing grasses and resistance to many chemicals means we will need more than one year to manage the grass seed bank if we compromise our knockdown and pre-emergent weed control by dry sowing.
Table 1 Actual paddock yields at Mudabie, 2006-2012 and lost production with later sowing compared to earlier sown crops

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield t/ha</th>
<th>kg loss/ha/day</th>
<th>loss/week %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0.51</td>
<td>6.5</td>
<td>8.9</td>
</tr>
<tr>
<td>2007</td>
<td>0.51</td>
<td>29.0</td>
<td>39.8</td>
</tr>
<tr>
<td>2008</td>
<td>0.55</td>
<td>11.0</td>
<td>14.0</td>
</tr>
<tr>
<td>2009</td>
<td>1.35</td>
<td>5.8</td>
<td>3.0</td>
</tr>
<tr>
<td>2010</td>
<td>1.44</td>
<td>12.2</td>
<td>5.9</td>
</tr>
<tr>
<td>2011</td>
<td>1.64</td>
<td>3.3</td>
<td>1.4</td>
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<tr>
<td>2012</td>
<td>0.60</td>
<td>3.3</td>
<td>3.9</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>10.2</td>
<td>11.0</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4 Paddock yields (t/ha) plotted against sowing dates from Mudabie, 2006

**Mudabie analysis**

Table 1 shows that as the crop is sown later, the likely yields are lower. In the last 7 years this loss has averaged 10.2 kg/ha per day which is 71 kg/ha or 11% per week. This is based on actual paddock yields at Mudabie, not model simulations. The penalty is significantly higher in years of low spring rainfall (2006, 2007 and 2008) when there is no subsoil moisture. 2012 had a dry spring but the crop yields were assisted by the mild spring weather.

Figure 4 is typical of the yield losses over time. 2006 was a year where some crops were sown early onto stored moisture and the balance was sown after a break in the season in June. The trend downwards suggests you should not have stopped seeding. The need for a germinating rain and improved weed control were the dominant factors in delaying seeding.

**What does this mean?**

Early sowing or dry sowing is important in a large cropping program and has yield and operational advantages. Careful paddock selection and prioritisation is required to ensure this strategy does not have long term impact on weed populations.

Time of seeding, varietal mix, seed and fertiliser rates combined with weed control and rotations are all management strategies we need to utilise. A best bet option is required as the variation between season and soil can change the outcomes and still cannot be predicted reliably prior to the season starting.

**Acknowledgements**


Yield Prophet® is an on-line modelling service based on APSIM that provides simulated crop growth based on individual paddock information and rainfall, and is registered to BCG.
The impact of livestock on paddock health
Roy Latta and Jessica Crettenden
SARDI, Minnipa Agricultural Centre

Key messages
• As a result of higher regenerating plant numbers the improved annual medic pasture carried double the livestock numbers compared to an unimproved pasture.
• There has been no measured change in soil organic carbon over the 5 year project as a result of varying crop and pasture inputs, and grazing or not grazing crop stubbles and pastures.

Why do the trial?
A trial was established on Minnipa Agricultural Centre in 2008 to test whether soil fertility and health could be improved under a higher input system compared to a lower input and more traditional system. The five year (2008-2012) wheat, wheat, pasture (annual medic), wheat, pasture (annual medic) rotation was also split for plus and minus grazing in both the high and low input systems to establish the impact of grazing between the two treatments.

How was it done?
In 2008 a 14 ha, red sandy loam (pH 7.7, CaCl) portion of a paddock on Minnipa Agricultural Centre was divided into 4 x 3.5 ha sections. Each section represented a system treatment: Traditional - grazed, Traditional – ungrazed, High input – ungrazed and High input - grazed. Four sampling points were selected and marked as permanent sampling points in each section. Data presented for each treatment are a mean of the four selected permanent points in each section. Weed control was imposed on all treatments as required in both summer and during the growing season.

In 2012 the trial was retained as a self regenerating annual medic pasture with no seed or fertiliser inputs. Selective chemical grass control was applied to the medic pasture. See EP Farming Systems Summary 2011 p 113 for 2008 - 2011 crop and pasture inputs.

What happened?
Soil fertility was estimated prior to seeding at five sites surrounding the four selected permanent points in each section. Table 1 presents the 2010, 2011 and 2012 phosphorous, total nitrogen and soil organic carbon results.

Colwell P trends show an increase following medic in 2010 across all treatments when 7 kg/ha of P was applied only to the high input treatments, in 2012 levels are similar across treatments following 15 and 8 kg/ha of P applied to the high and low input treatments respectively. 2012 soil analysis figures indicate there was a decline in residual N over the 2011 wheat season following the increased total N contents in response to the 2010 medic pasture. Soil organic carbon levels have been steady to trending higher with no evidence of a separation as a result of grazing or not grazing.

Pasture biomass was collected in 2012 from 5 x 0.1 m² quadrats sited at each of the 4 permanent points in each section. Table 2 presents the annual pasture establishment, biomass and seed yield in 2012.
Table 1 Colwell P (mg/kg 0-10 cm), total mineral nitrogen (kg N/ha 0-60 cm) and soil organic carbon (SOC%, 0-10 cm) in April 2010, 2011 and 2012 following wheat, annual medic and wheat respectively.

<table>
<thead>
<tr>
<th>System</th>
<th>Colwell P (mg/kg)</th>
<th>Total mineral nitrogen (kg N/ha)</th>
<th>Soil organic carbon (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional - grazed</td>
<td>25</td>
<td>41</td>
<td>34</td>
</tr>
<tr>
<td>Traditional - ungrazed</td>
<td>25</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>High input - grazed</td>
<td>17</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>High input - ungrazed</td>
<td>25</td>
<td>34</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 2 Annual medic establishment (plants/m²) total biomass (t DM/ha) measured in July, August, September and December with and without grazing, and medic seed production (t/ha) in 2012.

<table>
<thead>
<tr>
<th>System</th>
<th>Establishment (plants/m²)</th>
<th>Biomass (t DM/ha)</th>
<th>Seed yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medic (grass)</td>
<td>10 July</td>
<td>14 August</td>
</tr>
<tr>
<td>Traditional - grazed</td>
<td>233 (138)</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Traditional - ungrazed</td>
<td>284 (109)</td>
<td>0.2</td>
<td>0.8</td>
</tr>
<tr>
<td>High input - grazed</td>
<td>554 (39)</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>High input - ungrazed</td>
<td>652 (30)</td>
<td>0.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

There was less grass, increased biomass production and seed yield in response to the high input treatments with higher annual medic plant numbers. Grazing the medic pastures reduced seed yield and pasture residue that was measured on 7 December as opposed to their comparative ungrazed treatments. Both grazed treatments were stocked between 16 and 20 April, 10 July and 14 August, and 17 September and 5 October, 38 days at 11.25 and 22.5 DSE/ha growing season stocking rates for low and high input treatments respectively. 178 mm of growing season rainfall produced 2.7 t DM/ha in the 2012 improved pasture, which has an estimated water use efficiency (WUE) of 75% of potential, the unimproved pasture produced 1.6 t DM/ha, with 45% WUE.

**What does this mean?**

In 2012 an improved self-regenerating medic pasture reduced competing annual grass, increased biomass production and carried double the stocking rate, compared to a volunteer self-regenerating medic pasture. Although the stocking rate was quite low there was 1 to 1.5 t DM/ha retained on the grazed plots in early December which suggests there was opportunity for an increased stocking rate over the growing season while retaining adequate ground cover and with no expected loss in soil fertility or condition. The estimated livestock gross margins of $100/ha (2.5 DSE/ha @ $40/DSE) for the high input compares to $50/ha for the low input treatment. Although the high input medic has a 2010 $60/ha establishment cost it is spread over at least 6 pasture seasons, $10/ha/pasture year. The higher $ benefits derived from increased crop yields in response to more nitrogen fixed, better weed competition and root disease control, are forthcoming in 2013 and beyond.

**Acknowledgements**

We gratefully acknowledge the help of Mark Klante, Brett McEvoy and Trent Brace for their site management.
Crop sequences

Suzanne Holbery, Roy Latta & Ian Richter
SARDI, Minnipa Agricultural Centre

Eyre Peninsula Farming Systems 2012 Summary

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Key messages

- Wheat yields increased by 0.4 t/ha following a single legume break in 2011 compared to continuous wheat, which yielded 1.7 t/ha, held back by grassy weeds and depleted soil nutrients.
- Sulla was the most financially viable as a grazing option or hay crop.
- Oats as a break crop provided little opportunity to control grass weeds and this had a negative impact on the following wheat yield.

Why do the trial?
To determine the comparative performance of alternative crops and pastures as pest and disease breaks in an intensive cereal phase.

In low rainfall regions of south-eastern Australia broad-leaved crops make up only a very small proportion of the total area of sown crops. Farmers have adopted continuous cereal cropping strategies as non-cereal crops are perceived as riskier than cereals due to greater yield and price fluctuations. There is a need for non-cereal options to provide profitable rotational crops, disease breaks and weed control opportunities to sustain cereal production. A current ‘break crop’ may be a poorly performing volunteer annual grass dominant pasture. They are often havens for cereal pests and disease and are seen as having negative impacts on subsequent cereal grain yield and quality. However, breaks such as canola and peas are often perceived as too risky or too expensive to grow routinely.

How was it done?
The second year (2012) of the trial had 7 of the 20 treatments sown to Mace wheat @ 55 kg/ha, on 30 May. Five demonstrated the impact of a one year break in 2011 and two were continuous wheat. For the second year of the two year break treatments; Stingray canola (2 kg/ha), Twilight peas (80 kg/ha) and Winteroo oats (40 kg/ha) were sown on 2 May 2012. Regenerating Angel medic, early sown Angel medic and Sulla (Hedysarum coronarium) were also two year break treatments. Wheat, oat and canola treatments received 65 kg/ha DAP (18:20) and 50 kg/ha urea at time of sowing. An additional 50 kg/ha of urea was applied to canola on 25 July due to slow development of the plants.

All treatments excluding the continuous wheat and fallow plots were split into two sub-plots to demonstrate alternative enterprise options of grain, hay or grazing. In 2012 the sub plots demonstrated different enterprise options to 2011 where possible. Hay crops were cut prior to weed seed maturity on 18 September. Grazing was simulated by mowing the sub plots on 10 July, 17 August and 18 September. An additional mowing of oat treatments was measured on 17 October.

Weeds and pests were controlled in all treatments as required but with low cost options wherever possible and only in those treatments which required it at the time.

Due to heavy grassy weed pressure, the continuous wheat and wheat following vetch/oats were sprayed with Monza @ 30 g/ha mid season, other wheat treatments received only Hoegrass500 @ 1.1 L/ha. Due to late germinating grasses an application of Atlantis @ 0.33 L/ha was also applied on 8 August to the continuous wheat treatments. After simulated grazing through mowing the fallow plots were controlled with glyphosate applications.
What happened?

Root disease inoculum levels were monitored prior to sowing after each of the different types of break crops from year one. Pea treatments had levels of the Blackspot causing fungi in the high risk categories. The surrounding paddock had been sown with peas in 2011 and this may have influenced the result.

Pratylenchus neglectus levels were highest in continuous wheat but still at a low level. Medic treatments harboured highest levels of Pythium followed by peas but still at what appeared to be low levels. All other disease inoculum levels were low regardless of crop or pasture type in 2011.

Soil fertility early in 2012, except for total mineral N in the top 90 cm, was the same for all crop or pasture choices from 2011. The surrounding paddock had been sown with peas in 2011 and this may have influenced the result. Pratylenchus neglectus levels were highest in continuous wheat but still at a low level. Medic treatments harboured highest levels of Pythium followed by peas but still at what appeared to be low levels. All other disease inoculum levels were low regardless of crop or pasture type in 2011.

Soil fertility early in 2012, except for total mineral N in the top 90 cm, was the same for all crop or pasture choices from 2011. Mineral N was lowest following wheat or canola (52-59 kg N/ha) and highest following peas (97 kg N/ha). All other treatments were intermediate between these extremes.

Crop establishment in 2012 averaged 131 for wheat, canola 40, oats 76 and peas 45 plants/m². The yield of continuous wheat and the wheat following vetch/oats averaged 1.7 t/ha (Table 1). The other four wheat treatments (following a legume or canola/pea mix) averaged 2.1 t/ha. There was no difference in 2012 yields when comparing hay, grazing or grain options in 2011. Pea yields may have been negatively impacted due to a lack of moisture early in the season and cloddy soil that resulted in uneven germination. Peas and canola struggled in 2012, yielding less than half of wheat.

### Table 2 2012 and 2011 treatments, grazing biomass t DM/ha, dry sheep equivalents, gross margin (AUS $/ha)

<table>
<thead>
<tr>
<th>2012</th>
<th>2011</th>
<th>YIELD, t/ha</th>
<th>DSE/year/ha</th>
<th>AUS $ / ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESMedic Oats - Hay</td>
<td>3.2bc</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
<tr>
<td>ESMedic Canola - Grain</td>
<td>3.0bc</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
<tr>
<td>Fallow Fallow</td>
<td>0.4a</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
<tr>
<td>Oats ESMedic - Hay</td>
<td>3.1bc</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
<tr>
<td>Oats Canola - Grain</td>
<td>3.0bc</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
<tr>
<td>Oats Twi Pea - Grain</td>
<td>4.6ab</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
<tr>
<td>Sulla Sulla</td>
<td>4.3a</td>
<td>2.7</td>
<td>253</td>
<td>11</td>
</tr>
</tbody>
</table>

1.15% of total biomass was removed to allow for wastage. 2. DSE = Dry Sheep Equivalent. 3. $48 comes from the Gross Margins Guide 2012. 4. Calculated on 1kg/DSE/day average consumption on green pasture.
Grassy weed biomass in the grazed treatments was highest in oats. The fallow treatment was mown once on 10 July and consisted of large broad-leaved weeds, total dry matter was 0.4 t/ha.

The proportion of medic was measured separately in crop mixes and revealed that regenerated medic with sown canola was lowest with 1.3 t/ha, despite plant emergence established on March rainfall being the highest with 168 plants/m². Early sown medic following oats was highest with 3.3 t/ha, plant emergence 32 plants/m². The Early sown medic following canola had 1.8 t/ha medic biomass but only 25 plants/m².

The biennial legume Sulla produced the most biomass at 6.5 t/ha (Table 3). With hay prices estimated at $180/t Sulla as a hay crop was the most profitable over two years of all the treatments.

Oats had high grass weed burden with an average of 1.2 t/ha grassy biomass compared to the other treatments which had less than 0.1 t/ha.

The Minnipa region experienced a decile 3 year for 2012, with a good start but subsequently the crops were moisture stressed through spring. Water use efficiency (WUE) figures were calculated using the Hunt, J & Kirkegaard, J (2012). A guide to consistent and meaningful benchmarking of yield and reporting or water-use. CSIRO-Australia. Continuous wheat had the lowest WUE figure with 8.0 kg/ha/mm, the five other wheat treatments averaged 9.3 kg/ha/mm. Peas following oats recorded 4.6 kg/ha/mm compared to 3.3 kg/ha/mm following canola, and this was consistent with the yields that were 1.0 t/ha and 0.7 t/ha respectively.

What does this mean? In 2013 and 2014 the treatments will all return to wheat, and the effects of both a one and two year break on subsequent wheat yield and soil health will be better understood for the Minnipa environment.

The research so far has shown that:

• A one year break with a legume improved wheat yield the following year by 0.4 t/ha.
• Poor grass control in cereal treatments was an issue that impacted negatively on yield and reduced gross margins.
• Sulla may prove attractive for producers as a hay and/or a grazing option in its second year as costs are low once established.

Acknowledgements
GRDC “Profitable crop sequencing in low rainfall areas of south eastern Australia” DAS00119.
MONZA registered product of Nufarm, Hoegrass and Atlantis - registered products of Bayer crop science.

<table>
<thead>
<tr>
<th></th>
<th>2012 Yield</th>
<th>2011 Yield</th>
<th>AUS $/ha</th>
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<tbody>
<tr>
<td>Canola</td>
<td>3.7a</td>
<td>592</td>
<td>417</td>
</tr>
<tr>
<td>Canola</td>
<td>4.7a</td>
<td>752</td>
<td>464</td>
</tr>
<tr>
<td>Canola</td>
<td>4.5a</td>
<td>736</td>
<td>459</td>
</tr>
<tr>
<td>Pea</td>
<td>2.2b</td>
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<td>339</td>
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<td>Pea</td>
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<td>385</td>
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<td>Med/Can</td>
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<td>432</td>
<td>284</td>
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<td>Sulla</td>
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<td>1170</td>
<td>399</td>
</tr>
<tr>
<td>Oats</td>
<td>5.5a</td>
<td>896</td>
<td>473</td>
</tr>
<tr>
<td>Oats</td>
<td>5.2a</td>
<td>832</td>
<td>454</td>
</tr>
<tr>
<td>Oats</td>
<td>4.7a</td>
<td>762</td>
<td>431</td>
</tr>
<tr>
<td>Wheat</td>
<td>4.9a</td>
<td>784</td>
<td>467</td>
</tr>
</tbody>
</table>

1.15% was removed from biomass to allow for wastage. 2. 15% was added to biomass to allow for moisture content of baled hay. 3. Hay prices were estimated from The Stock Journal, 1 December 2012.
Responsive farming for soil type at Wharminda

Cathy Paterson, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

**Why do the trial?**
It is important that our low rainfall farming systems are low risk, flexible and responsive. Paddock inputs need to balance the best agronomic and economic advice with the need to ensure reliable outcomes at low cost. At Mudamuckla, one of three focus paddocks in the current GRDC funded Eyre Peninsula Farming Systems 3 project, the emphasis is on managing risk through tailoring inputs to different production zones by using variable rate technology.

Changing inputs according to the production capability of different paddock zones or soil types may provide an opportunity to improve gross margins for the whole paddock and improve water use efficiency.

**How was it done?**
Paddock 8 at Mudabie Farm was segregated into zones of good (grey calcareous sandy loam), medium (sandier hills) and poor (magnesia flats) production zones in 2009 using 5 years of yield maps and an elevation map (EPFS Summary 2009, pp 97-103). The areas in the paddock represented by these zones are 40% for the good, 45% for the medium and 15% for the poor.

The paddock was sown to Mace wheat on 29 May 2012 using variable rate technology (VRT) to apply 4 different rates of phosphorus (P) as phosphoric acid in seeder runs approximately 1.3 km long. Four permanent sampling points in each of the good, medium and poor zones were established in 2009 enabling soil chemical analysis, plant establishment, dry matter at anthesis, soil water measurements (sowing and harvest) and grain yield to be monitored separately for each zone. Due to the late, dry start to the growing season it was decided to apply nitrogen (N) as urea @ 9 kg N/ha in all zones to ensure plant growth after establishment was maximised.

A single demonstration strip of 16 kg P/ha, that has been applied every year since 2009 was harvested separately but no other measurements for this strip were taken during the year.

**What happened?**
Pre-seeding Colwell P levels tended to be lower in the good zone as compared to the other zones, while the DGT P levels were similar in all zones and below the critical level of 50 μg/L. There was more total mineral N measured in the poor zone than the good or medium zones (Table 2). There was a response to P in dry matter production at anthesis in the good zone of the paddock but only to 8 kg P/ha. There was only a yield response to P when it was applied at 16 kg P/ha in the good zone, in the poor zone applying P at all rates increased yield. There was good grain quality in all 3 zones and there was no response in quality to applied P.

To compare the value of VRT for this soil type a basic economic analysis was carried out on the combinations outlined in Table 4.
These VRT combinations were then compared to the potential gross margins if the different input rates had been applied to the whole paddock (Table 4) taking into account the percentage areas that the different production zones represent.

In 2012 the VRT – “Go for gold!” strategy resulted in a similar gross income than if the standard treatment had been applied across the whole paddock (Table 5). The more conservative VRT approach “Hold the gold!” gave a lower gross income than the standard input strategy.

What does this mean? In 2012 the VRT – Go for gold! strategy resulted in a similar gross income to the standard blanket approach even after taking into account the higher input costs in the good zone of the Go for gold! strategy. The Go for gold! strategy matches the farmer’s current VRT strategy (higher fertiliser inputs on the more reliable zones and a lower seeding rate and no fertiliser inputs on the poor zone) and covered costs, even in a dry year such as 2012. A more conservative approach such as the VRT – Hold the gold! strategy resulted in a lower gross income than the standard and Go for gold! treatments.

Determining inputs for different soil zones is dependent on knowing where these zones are, knowing what the production potential is for different zones of paddocks (eg. soil type, presence of subsoil constraints, nutrient availability) and then balancing this with the business financial position, perception of the season and personal approach to risk.

Acknowledgements
We acknowledge the funding from GRDC project UA00107 for this work. Thanks to Peter Kuhlmann for providing the land for this trial and to Andre Eylward and Paulus Viljoen for sowing the paddock and their help during the year.

Table 1 Soil chemical analysis for Mudamuckla in 2012

<table>
<thead>
<tr>
<th>Zone</th>
<th>Colwell P 0-10cm (mg/kg)</th>
<th>DGT P 0-10 cm (µg/L)</th>
<th>Total Mineral N 0-60 cm (kg/ha)</th>
<th>*Depth to B &gt;15 mg/kg (cm)</th>
<th>*Depth to CI &gt;1000 mg/kg (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>40</td>
<td>15</td>
<td>65</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Medium</td>
<td>45</td>
<td>15</td>
<td>80</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Poor</td>
<td>44</td>
<td>17</td>
<td>192</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>

*2009 data

Table 2 Plants/m², dry matter production (DM t/ha), grain yield (t/ha) and grain quality, Mudamuckla 2012

<table>
<thead>
<tr>
<th>Zones</th>
<th>Phos. Acid (kg P/ha)</th>
<th>Seeding Rate (kg/ha)</th>
<th>Establishment (plants/m²)</th>
<th>Anthesis DM (t/ha)</th>
<th>Grain Yield (t/ha)</th>
<th>Test wt (kg/hL)</th>
<th>Protein (%)</th>
<th>Screenings (%)</th>
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</thead>
<tbody>
<tr>
<td>Good</td>
<td>0</td>
<td>45</td>
<td>131</td>
<td>1.9</td>
<td>0.45</td>
<td>84.0</td>
<td>11.6</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>60</td>
<td>141</td>
<td>1.8</td>
<td>0.54</td>
<td>84.3</td>
<td>11.4</td>
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<td></td>
<td>8</td>
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<td>11.6</td>
<td>3.0</td>
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<td></td>
<td>16</td>
<td>60</td>
<td>n/a</td>
<td>n/a</td>
<td>0.69</td>
<td>83.6</td>
<td>12.8</td>
<td>4.8</td>
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<td>Medium</td>
<td>0</td>
<td>45</td>
<td>119</td>
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<td>0.44</td>
<td>84.2</td>
<td>12.7</td>
<td>2.6</td>
</tr>
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<td>145</td>
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<td>84.4</td>
<td>12.8</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>8</td>
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<td>177</td>
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<td>0.48</td>
<td>84.4</td>
<td>12.6</td>
<td>2.0</td>
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<td></td>
<td>16</td>
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<td>n/a</td>
<td>n/a</td>
<td>0.51</td>
<td>84.2</td>
<td>12.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>45</td>
<td>100</td>
<td>1.3</td>
<td>0.29</td>
<td>83.7</td>
<td>12.7</td>
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<td>4</td>
<td>60</td>
<td>109</td>
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<td>0.46</td>
<td>84.8</td>
<td>12.5</td>
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<tr>
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<td>121</td>
<td>1.1</td>
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<td>84.8</td>
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<td>60</td>
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<td>n/a</td>
<td>0.40</td>
<td>83.1</td>
<td>12.8</td>
<td>2.9</td>
</tr>
</tbody>
</table>

LSD (P=0.05) 41 0.49 0.75 ns ns ns

Table 3 Treatments applied to VRT gross income analysis for Mudamuckla 2012

<table>
<thead>
<tr>
<th>Paddock Zone</th>
<th>VRT - Go for gold!</th>
<th>Inputs</th>
<th>VRT - Hold the gold!</th>
<th>Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg P/ha</td>
<td>Seeding rate (kg/ha)</td>
<td>kg P/ha</td>
<td>Seeding rate (kg/ha)</td>
</tr>
<tr>
<td>Good</td>
<td>High</td>
<td>8</td>
<td>60</td>
<td>Standard</td>
</tr>
<tr>
<td>Medium</td>
<td>Standard</td>
<td>4</td>
<td>60</td>
<td>Low</td>
</tr>
<tr>
<td>Poor</td>
<td>Low</td>
<td>0</td>
<td>45</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 4 Comparison of the gross income of different sowing regimes vs. VRT combinations across the whole 200 ha paddock

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Gross income¹ ($/ha)</th>
<th>Gross income compared to standard input treatment ($/200 ha paddock)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRT – Go for gold!</td>
<td>108</td>
<td>-153</td>
</tr>
<tr>
<td>VRT – Hold the gold!</td>
<td>82</td>
<td>-5430</td>
</tr>
<tr>
<td>High input across whole paddock</td>
<td>95</td>
<td>-2860</td>
</tr>
<tr>
<td>Standard input across whole paddock</td>
<td>109</td>
<td>0</td>
</tr>
<tr>
<td>Low input across whole paddock</td>
<td>91</td>
<td>-3650</td>
</tr>
</tbody>
</table>

¹ Gross income is yield x price grain (H2 Wheat $270/t) less seed ($350/t) and fertiliser ($4.15/kg P) costs.
Managing inputs to soil type in EP farming systems at Minnipa
Cathy Paterson, Roy Latta, Wade Shepperd and Ian Richter
SARDI, Minnipa Agricultural Centre

Key messages
- In 2012 medic biomass production in paddock N1 was higher in the soil type with more plant available water in the root zone.
- There was no biomass increase as a result of higher residual P levels.

Why do the trial?
Variability in soil and seasons are key drivers of crop productivity, and the use of soil and season specific inputs are becoming more common. In Minnipa Agricultural Centre North 1 paddock an EM38 survey, yield maps and soil testing have been used to create zones representing good, medium and poor performing areas (EPFS Summary 2008-11).

After 4 years of cereal rotation (wheat, wheat, wheat, barley) with low, standard and high inputs applied across the paddock zones, grass weeds had become a major issue and root disease inoculum levels were high. This resulted in the paddock being returned to a medic phase in 2012 with the opportunity to measure response in biomass to the 2008 to 2011 applied fertiliser rates.

How was it done?
Representative soils within these zones were characterised for plant available water capacity (PAWC) and chemical constraints such as pH, boron and chloride before seeding in 2008, as well as chemical analysis for plant available nutrients before seeding in 2012 (Table 1).

Annual medic was sown @ 10 kg/ha with unscarified seed harvested from paddock N5N plus 1 kg/ha Angel medic with no fertiliser on 26 April following 15 mm of rain on 21 April. The unscarified seed was tested at 50% viability, giving a total sowing rate of 6 kg/ha germinable seed. Measurements taken during the season included soil chemical analysis, soil water content, medic plant establishment, dry matter production and ground cover percentage.

The 61 ha paddock was stocked from 14 June until 9 July with 351 hoggets grazing on medic, self-sown barley and barley grass before a grass selective herbicide was applied. Grazing also occurred between 24 August and 20 September with 350 ewes and 420 lambs. The overall stocking rate was estimated as 2.5 DSE/winter grazed ha with a total gross margin of approximately $100/ha. Sheep exclusion cages were fixed in the 3 zones within the 3 input rate treatments prior to the 24 August grazing.

What happened?
Colwell P levels measured before seeding were positively correlated to historic levels of P inputs in the good and medium zones, with the highest levels measured in the 2008-11 high input treatment. This relationship was not as strong in the poor zone, although higher Colwell P levels were measured where-ever P had been applied, i.e. the high and standard input treatments.

In all zones where no P has been applied in the previous 4 years the Colwell P was below the critical level of 26 mg/kg (Holloway pers. comm.). However the correlation between Colwell P levels and medic biomass this season was not strong. While there was a high level of variation in the results there was no clear response to the previously applied fertiliser treatments whereas medic production response to each of the 3 zones was quite different.

The possible reasons are discussed below;

Approximately 5 plants/m² of medic germinated from paddock seed reserves after the initial 30 mm rain from 27 February to 7 March, these plants were sustained by a further 18 mm in April. The unscarified seed was tested at 50% viability, giving a total sowing rate of 6 kg/ha germinable seed. Measurements taken during the season included soil chemical analysis, soil water content, medic plant establishment, dry matter production and ground cover percentage.

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The possible reasons are discussed below;

Approximately 5 plants/m² of medic germinated from paddock seed reserves after the initial 30 mm rain from 27 February to 7 March, these plants were sustained by a further 18 mm in April. The April rainfall event initiated medic seeding on the 26 April. There was no further rain until 24 May when 16 mm fell and although a total of more than 100 plants/m² established in all zones (Table 2) the biomass production was dominated by the early germinating plants throughout the season. Cold winter temperatures also reduced plant growth rates.
The paddock was grazed from June into July removing much of the early biomass production before any measurements were taken. The sown and established medic were allowed to regrow until sampling and subsequent grazing in August. This sampling found a difference in biomass production between zones (Table 2) but not between the different input levels within each zone. The zone biomass difference was considered to be due to the increased available soil water of the medium zone in the 0.6 m medic root zone compared to the good zone and the shallower 0.4 m rooting depth of the poor zone.

No further rain through to the September sampling ensured no further production was made with similar total biomass figures from the ungrazed caged areas as the August biomass figures (Table 2). The dry spring would also reduce the response to nutrients, plus a calculated average growth rate of 10 kg DM/ha/day from 9 July until 21 September would have resulted in little pressure on limited nutrient resources.

**What does this mean?**
The production response to zones was maintained where in a season with adequate soil water over winter the medium zone produced more biomass than the good or poor zones due to more plant available water in the medic rooting zone.

The decision to establish a pasture phase has provided valuable winter grazing along with the opportunity to economically control annual grasses with a selective Group A herbicide. Although it never reached 50% of potential, the biomass produced would add 30-60 kg/ha of N to the soil bank, plus it has provided a cereal root disease break. The total value of this medic phase including the subsequent cereal crop benefit may total $200/ha, dependent on the 2013 seasonal conditions. The cost of the purchased and on-farm seed, plus the selective herbicide totals around $20, a 1000% return on investment.

**Acknowledgements**
Thanks to Mark Klante, Brett McEvoy and Trent Brace for sowing and managing this trial and to Therese McBeath for all her technical advice and support. Thanks to GRDC for funding the EP Farming Systems 3 project UA00107.
Demonstrating variable rate technology at Wharminda in 2012

Linden Masters¹ and Ian Noble²

¹SARDI Minnipa Agricultural Centre, ²Farmer, Wharminda

Searching for answers

Location: Wharminda
Rainfall:
Av. Annual: 320 mm
Av. GSR: 250 mm
2012 Total: 225 mm
2012 GSR: 211 mm
Yield
Justicia wheat 1.4 t/ha, 11% protein, 2% screenings

Paddock History
2011: Peas, wheat, pasture (fences removed before 2012 seeding)
2010: Barley, wheat
2009: Wheat

Soil Type
Sand over calcrete, sand over clay and deep sand

Soil Test
Table 1
Plot Size
200 ha, two x 2 km reps of 3 double air-seeder widths
Time of Sowing
28 April

Yield Limiting Factors
Poor germination due to seed used, and sowing into drying conditions.
Non-wetting soil hindered early plant emergence.
Ryegrass competition.
Early finish with no spring rain.

Key messages
- Combining machinery capability with advances in soil testing enables easy demonstration of variable rate technology (VRT) practices across different soil types and production zones.

- EM38 mapping gave the same signal for limestone and deep sand making ground truthing even more important.
- There were no consistent yield differences between different rates of the same fertiliser at seeding so there is scope for fertiliser inputs to be adjusted.
- An initial zone map developed solely from EM38 mapping didn’t fully capture soil variability so will need to be developed further.
- Targeted management could be improved by increasing variable seeding rates to achieve higher plant numbers and competition and adjust fertiliser rates using a revised zone map.
- The next step is to further refine the variable rate map and treatments using yield data and local agronomic knowledge, as an important component of variable rate is to constantly improve results and returns through on-farm trials and analysis.

What did you do and why did you do it?
Ian wanted to gain experience with his Topcon X20 controller and the variable rate capacity fitted to his Simplicity air cart. The paddock under study was EM38 mapped with soil sampling and analysis conducted to ground truth EM38 zones and starting soil phosphorus (P) levels. This information was used to create a P fertiliser prescription map with the aim of improving or maintaining yields while reducing total input costs for the paddock. The system had to be reliable and sufficiently robust to be used by inexperienced operators.

For the GRDC funded EP Farming Systems 3 water use efficiency project, this demonstration gave an opportunity to apply the responsive farming systems approach at a farm level. Using EM38, soil testing and VRT, appropriate P fertiliser applications for managing input risks on three distinct soil types at Wharminda was determined.

How did you do it?
The paddock was EM38 mapped (Figure 1) by Peter Treloar and strategically soil tested to develop a VRT map comprising three major zones. Justicia wheat was sown @ 50 kg/ha with 27:12 fertiliser on 5 March, using a Simplicity air cart and Morris bar, knife points and press wheels.

Treatments:
- Paddock mapped into 3 zones with 30, 60 or 80 kg/ha of 27:12 fertiliser applied in each zone. Three demonstration strips of 0, 50 and 80 kg/ha of 27:12 were replicated twice across all soil zones with the aim of ground truthing future paddock recommendations. Each strip was two air-seeder widths of 30.48 m (100 ft) x 2 km (Figure 1).
- Chemical applied 4 March 1.0 L/ha glyphosate, 70 ml/ha Stiker®; 28 June 900 ml/ha Midas®.
Table 1 Soil test results from Wharinda, 2012

<table>
<thead>
<tr>
<th>EM Zones</th>
<th>Colwell P (mg/kg)</th>
<th>PBI</th>
<th>Critical Colwell P (mg/kg)</th>
<th>Colwell P minus Critical Colwell P (mg/kg)</th>
<th>cDGT (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE180</td>
<td>38</td>
<td>30</td>
<td>18</td>
<td>20</td>
<td>118</td>
</tr>
<tr>
<td>NW180</td>
<td>11</td>
<td>101</td>
<td>28</td>
<td>-18</td>
<td>31</td>
</tr>
<tr>
<td>S137 flat</td>
<td>44</td>
<td>10</td>
<td>11</td>
<td>33</td>
<td>217</td>
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<tr>
<td>S100</td>
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<td>29</td>
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<td>18</td>
<td>87</td>
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<tr>
<td>S25 sand</td>
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<td>9</td>
<td>-2</td>
<td>85</td>
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<tr>
<td>N74 flood</td>
<td>14</td>
<td>79</td>
<td>26</td>
<td>-12</td>
<td>25</td>
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</tbody>
</table>

Figure 1 EM38 VRT zones with demonstration strips

Fertiliser rates
Paddock
Dark grey 80 kg/ha
Light grey 60 kg/ha
Medium grey 30 kg/ha
Trial strips
Dark grey 80 kg/ha
Light grey 50 kg/ha
White 0 kg/ha
What happened?
The soil test results showed a wide variation in Colwell P, PBI and DGT P across the paddock (Table 1).

The soil tests show that in N74 there is a need for extra P as this is part of an area scoured by floodwaters (Figure 1). S25 is a deep drifted sand hill lacking in P. S137 is a very productive area of the paddock.

Despite a good rain (24 mm) on 22 April, the crop was sown into a drying soil moisture profile and on sandier parts of the paddock failed to germinate until the next rain event of 48 mm (20 to 23 May). Better early crop growth was observed for several months after emergence in the higher fertiliser strips, however these strips were less noticeable as the crop matured.

A lack of spring rainfall resulted in the crop failing to reach potential yields. Grain yields varied from 0.5 to 2.5 t/ha across the paddock. There were no consistent differences between yield with the different rates of fertiliser applied in test strips.

What does this mean?
Fertiliser had little impact on yield with no consistent yield variation evident in treatments. This is supported by the soil testing showing excellent levels of P in most areas.

Visually better crop in the high fertiliser strips could have resulted from the extra N in 27:12:- but it did not increase grain yield even though strips were visible until Zadoks growth stage 41. Given the high P reserves across the paddock, an option we are considering for the 2013 crop is to use a replacement P strategy where fertiliser rates are determined from the header yield map of 2012, assuming the crop removed 3-4 kg of P per tonne of grain harvested.

Nitrogen testing of soil organic carbon, nitrate and ammonium levels throughout the root zone give a basis for N management. Seasonal conditions can dictate available N and further requirements.

The process of testing the soil and setting up the monitor has given Ian the confidence to continue using VR seeding in the future. Ian hopes to use VR technology to redistribute fertiliser inputs to increase profitability. He would also like to vary seeding rate to compete with weeds, improve germination and plant densities on lighter soils. He intends to increase the area that is sown to VR next year using more EM38 mapping and analysing yield maps.

The next step is to further refine the variable rate map and treatments using yield data and local agronomic knowledge, as the most important component of variable rate is to constantly improve results and returns through on-farm trials and analysis.

Acknowledgements
Brett Masters, Sean Mason, Kendall Curtis and Peter Treloar. GRDC Eyre Peninsula Farming Systems 3 project UA00107.