Soils & Tillage

Stubble and nutrient management trial to increase soil carbon

Amanda Cook1, Harm van Rees2, Wade Shepperd1 and Ian Richter1

1SARDI, Minnipa Agricultural Centre, 2CropFacts Pty Ltd

Why do the trial?
This DAFF funded national trial will examine existing, new and alternative strategies for farmers in the wheat/sheep zone to increase soil carbon. The trial will be used as base line data for carbon accumulation in soils and to;
• discuss the various forms of soil organic carbon (plant residues, particulate, humus and recalcitrant)
• investigate how management affects each of these pools and how humus can be increased over the medium to long term
• communicate how soil organic matter affects soil productivity (through nutrient and water supply, and improvements in soils structure).

How was it done?
Four wheat stubble samples from 2011 were collected in MAC S2/8 in May across the trial site and dried at 40°C for 24 hours to calculate the stubble load.

In May the stubble management treatments of (i) Stubble left standing, (ii) Stubble worked in with single operation of the seeder using knife points before sowing (18 May), (iii) Stubble raked and burnt (21 May) were imposed.

Nutrient application treatments at seeding were: (i) normal practice for P at sowing and N in crop as per Yield Prophet recommendations; (ii) normal practice PLUS extra nutrients (N, P, S) required to break down the measured wheat stubble which is 5.8 kg N/t of wheat stubble, 2.2 kg P/t of stubble and 0.9 kg S/t of wheat stubble. The treatments were replicated 4 times.

The trial was sown on 30 May with Scout wheat @ 60 kg/ha and base fertiliser of DAP (18:20:0:0) @ 50 kg/ha. The extra nutrient requirement applied (N, P and S) at sowing to break down the stubble load was 19.5 units P, 33.9 units N and 3.8 units S, which was applied as DAP @ 97.5 kg/ha, ammonium sulphate (21:0:0:24) @ 16 kg/ha and urea (46:0:0:0) @ 28.5 kg/ha.

Emergence counts, flowering date and grain yield and grain quality were measured.
Table 1 Yield (t/ha) and grain quality measurements of stubble and nutrition treatments at MAC, 2012

<table>
<thead>
<tr>
<th>Stubble treatment</th>
<th>Nutrition treatment</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
<th>Test weight (g/hL)</th>
<th>1000 Grain weight (gm)</th>
<th>Screenings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stubble removed</td>
<td>DAP @ 50kg/ha</td>
<td>1.34</td>
<td>11.65</td>
<td>84.32</td>
<td>30.66</td>
<td>4.8</td>
</tr>
<tr>
<td>Stubble removed</td>
<td>normal practice PLUS N, P &amp; S</td>
<td>1.35</td>
<td>11.85</td>
<td>83.85</td>
<td>30.48</td>
<td>4.6</td>
</tr>
<tr>
<td>Stubble standing</td>
<td>DAP @ 50kg/ha</td>
<td>1.29</td>
<td>11.70</td>
<td>83.84</td>
<td>29.52</td>
<td>4.6</td>
</tr>
<tr>
<td>Stubble standing</td>
<td>normal practice PLUS N, P &amp; S</td>
<td>1.24</td>
<td>11.75</td>
<td>83.84</td>
<td>29.28</td>
<td>5.1</td>
</tr>
<tr>
<td>Stubble worked</td>
<td>DAP @ 50kg/ha</td>
<td>1.25</td>
<td>11.65</td>
<td>84.15</td>
<td>30.26</td>
<td>5.6</td>
</tr>
<tr>
<td>Stubble worked</td>
<td>normal practice PLUS N, P &amp; S</td>
<td>1.24</td>
<td>11.60</td>
<td>83.81</td>
<td>30.41</td>
<td>5.7</td>
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<td>LSD (P=0.05)</td>
<td></td>
<td>0.08</td>
<td>ns</td>
<td>ns</td>
<td>0.54</td>
<td>0.7</td>
</tr>
</tbody>
</table>

What happened?
The mean stubble load calculated was 4.33 t/ha.

Emergence counts were taken on the 26 June with an average of 95 plants/m². There were no differences between treatments with plant emergence. Due to seasonal conditions, low rainfall and hot weather around 18 September, there were no differences in flowering date (GS 65 (when 50% of heads have anthers)) which occurred between the 18 and 21 September.

The trial was harvested on 6 November. The results are presented in Table 1.

Yield Prophet was used early in the season (30 July) to predict if extra nitrogen fertiliser was required to achieve potential yield. The report showed 200 kg/ha of soil nitrogen was available to the crop so extra nitrogen did not need to be applied to increase plant growth. The soil moisture profile at this stage of the season was almost at capacity.

What does this mean?
A decile 3 season, with little spring rainfall resulted in a very tight finish to the season. Flowering time was condensed due to higher temperatures between 18 and 21 September. Soil nitrogen was not a limiting factor in this paddock this season so no extra in-crop nitrogen was applied.

Soil moisture may have been a limiting factor as the treatment with stubble removed had increased yields. In this season the removal of stubble may have allowed better infiltration of rainfall and increased soil moisture available to the plant. The extra nutrient treatment had no effect on grain yield or quality this season.

It is expected that the imposed treatments to increase soil organic matter will take a few years to become noticeable. The trial will be repeated on the same site for at least the next two years.

Acknowledgements
Funding provided from DAFF, GRDC and CEF and project management through Ag Ex Alliance, BCG and EPARF. Yield Prophet® is an on-line modeling service based on APSIM that provides simulated crop growth based on individual paddock information and rainfall, and is registered to BCG.
Managing problem sandhills for reduced erosion risk and improved productivity

Brett Masters¹ and Linden Masters²

¹Rural Solutions SA, Port Lincoln, ²SARDI and EPNRM, Minnipa Agricultural Centre

Key messages

- Fill in blowholes using best practice techniques.
- Where suitable clay is present within operating depths, clay spread or delve the area to address such issues as water repellence and low inherent fertility.
- Ensure there is adequate moisture to quickly re-establish surface cover.
- Ensure that the site has adequate soil nutrition by applying fertilisers (including trace elements) where required.
- Remove stock from the area to enable surface cover to establish.
- To reduce erosion risk, surface cover should be well anchored and at least 2 cm in height with moderate bulk.
- Once cover has established grazing should be carefully monitored. Set stocking is not advised and electric fencing can be used to keep stock from the site.
- Build up soil organic carbon levels using stubble retention, and perennial pastures where applicable.

Why do the demonstration?
Sandhills within cropping and grazing paddocks, though often productive, provide continual management challenges to maintaining adequate surface cover for wind erosion protection. Issues such as water repellence, low inherent fertility and low water holding capacity require careful and specialised management to reduce the risk of wind erosion on these sites.

Where deep sandy sites are exposed to continual wind erosion events blow-outs can form, which if not managed effectively can increase in size, becoming more difficult to rehabilitate and increasing impact on production.

The aim of the EPNRM Board’s “Supporting Soil Protection and Health on Upper Eyre Peninsula” project is to work with landholders in western, central and eastern Eyre districts to help them address soil constraints and wind erosion risk on susceptible soils. Demonstration sites in five districts will showcase how landholders can re-establish problem areas of their properties and bring them back into profitable production.

How was it done?

Landholders within the target area were asked to submit an expression of interest. These properties were visited and a plan detailing appropriate management actions for the site was developed in consultation with the landholder.

Technical support to the management plan was provided. Management options considered included; levelling paddocks by filling in blow outs, fencing to land class, applying biosolids to increase organic carbon and moisture holding capacity, clay delving, establishing perennial pastures, revegetation and better managing stock movement by shifting water troughs and tanks and using electric fencing for better grazing management on susceptible areas. Photographs were taken pre and post treatment and surface cover is being monitored.

What happened?

Sandhill rehabilitation
A number of landholders chose to manage particularly susceptible areas of the paddock by filling in blow outs to level the paddock, then sowing the site to an annual cereal to rapidly establish surface cover for wind erosion protection.

Levelling the site
Using a scraper (contractor machine or modified cultivator/dozer) sand was moved down from the tops of the hills toward the flats. This filled in the blow-outs but in some instances also brought the tops of the sandhills to a height that would allow clay to be reached with a delver. Conducting this operation whilst the soil was moist reduced the risk of erosion and made it easier to re-establish cover on the paddock. Where the operation was conducted on dry soil it was difficult to get re-establishment of surface cover and left the site prone to drift.
Establishing and maintaining cover

Sowing the site with cereal rye or triticale provided rapid crop establishment and quickly provided surface cover for wind erosion protection. These crops are recommended for wind erosion susceptible sites as they are tall growing and establish an extensive root system, helping to bind the soil together. They also seem to recover better from sandblasting than other crop types. Where wheat was sown the crop did not have the same early vigour as cereal rye, leaving the soil exposed for longer and plants susceptible to sandblasting.

A number of different sowing techniques were used on sites including sowing along or across slopes and “cross-hatching” (planting half of the seed in one direction and sowing the remaining seed at 90 degrees to the initial direction). The best success for establishing surface cover seemed to be where growers had sown in a cross hatch at a high rate (up to 180 kg/ha).

Well anchored cover will protect soil from wind erosion for a distance of up to 10 times its height. Where surface cover is well anchored and of moderate bulk above 2 cm in height the site is generally considered to have a low wind erosion risk.

Managing stock movement was critical to ensuring that adequate surface cover for wind erosion protection was maintained post establishment. The use of electric fencing allowed landholders to graze stubbles on the areas of the paddock with low erosion risk whilst excluding stock from high risk areas.

Other options for managing the sites

There were a number of other options employed by landholders under the project to effectively manage their high erosion risk sites. These options included;

- Clay spreading and delving sites where there is suitable clay within an appropriate depth.
- Establishing perennial pastures (including perennial veldt grass and lucerne).
- Establishing rows of perennial shrubs to act as a wind break.
- Spreading biosolids over the surface of the site to increase organic matter for improved root development.

Long term strategies for managing these areas include;

- Minimising soil disturbance by using no-till technologies for seeding.
- Using electric fencing to manage grazing for protecting at-risk soils.
- Building organic matter through retaining stubble.
- Fencing off at-risk areas and investigating alternative land use options to lower erosion risk including the establishment of perennial pastures such as lucerne and perennial veldt grass.

What does this mean?

Any cultivation on susceptible sites (including levelling out blow outs) should be done whilst the soil is moist and cover re-established on the site as quickly as possible. It is recommended that these sites be managed to maximise surface cover by growing appropriate plant species at a high density and adequately managing grazing using electric fencing and stock exclusion.

There are extensive areas of susceptible soil across the region and state which require specialised and careful management strategies in order to reduce the risk of erosion. It is expected that the twenty focus sites over five districts will allow these land managers to showcase better alternative strategies of managing these problem areas in the future.

Acknowledgements

This project is supported by the Eyre Peninsula Natural Resources Management Board with funding from Caring for our Country. All landholders involved in the Supporting Soil Protection and Health project, EPNRM for the funding support, Regional Landcare Facilitators Linden Masters (SARDI), Neil Ackland and Corey Yeates (DEWNR) and Mary Crawford (Rural Solutions SA) for project delivery.
Key messages

- If using sown cereals for pasture, choose varieties carefully to avoid potential disease issues.
- The impact of various seasonal factors on N mineralisation can advantage farming systems differently between seasons.
- Grass control in pastures and summer weed control are vital for achieving No-till success.

Why do the trial?
This paddock trial aims to better understand why many farmers with livestock find it difficult to No-till into pasture ground, and to give them practical management options for both the pasture and cropping phases that will help maximise outcomes, while reducing the risk of wind erosion.

How was it done?
Part A of this 3 year Grain and Graze 2 project compared 2011 wheat crops that followed 2010 grass free and spray topped pastures in 2010 (for full report go to https://msfp.org.au/docs/research_74.pdf).

Part B compared 2012 wheat crops following sown cereal pastures and volunteer pastures in both the southern (Wynarka) and northern (Wunkar) Mallee last season. The Wynarka paddock used cereal rye as the cereal pasture and was very clean of other grassy or broad-leaved weeds, while the Wunkar site had oats trashed in and had brome and barley grass, wild turnip and capeweed. In this dry season at both sites the volunteer pasture sections of capeweed, wild turnip and grass were poor leading to increased erosion risk from these sections. Observations suggested that the bulk of the paddock feed was obtained from the sown cereal sections (although areas were not separately fenced or measured).

In 2011 and 2012, 4 crop establishment treatments were used across the original pasture treatments:
1. early worked (EW) after rains in late February and worked again 1 week prior to seeding
2. late worked (LW) 1 week prior to sowing
3. No-till (NT)
4. No-till with higher inputs (NTH)

The trials were paddock scale using farmer equipment with all treatments replicated, and main soil types measured separately. The conclusions drawn reflect the clear and consistent results obtained irrespective of the variation across the paddock. This article mainly presents 2012 results (Part B) but will then also draw recommendations based on Part A and the overall project results and observations.

What happened?
Previously Part A of the project had clearly shown low rhizoctonia build up after grass free pasture, medium levels following spray topped pastures in 2010 (for full report go to https://msfp.org.au/docs/research_74.pdf).

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What happened?
Previously Part A of the project had clearly shown low rhizoctonia build up after grass free pasture, medium levels following spray topped and very high levels where autumn growth was not controlled. In last years’ trial, however, the low/medium rhizoctonia level in December at Wynarka, and the medium/high levels at Wunkar had an over 80% reduction in rhizoctonia inoculum to low levels (Table 1). This was thought to be mainly due to significant summer rainfall events in both December and February. While seeding into these low levels, crop monitoring still showed an average of 30-35% root loss at both sites.
Table 1 Effects of 2011 pasture type on disease inoculum and 2012 wheat yield (t/ha)

<table>
<thead>
<tr>
<th>Pasture</th>
<th>2011</th>
<th>2012</th>
<th>Wunkar</th>
<th>Pasture</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rhizoctonia</td>
<td>Bipolaris*</td>
<td>Yield (t/ha)</td>
<td>Rhizoctonia</td>
<td>Bipolaris*</td>
<td>Yield (t/ha)</td>
</tr>
<tr>
<td>Wynarka</td>
<td>pgDNA/g</td>
<td>pgDNA/g</td>
<td>Dec 2011</td>
<td>May 2012</td>
<td>Dec 2011</td>
<td>May 2012</td>
</tr>
<tr>
<td>Wunkar</td>
<td>pgDNA/g</td>
<td>pgDNA/g</td>
<td>Dec 2011</td>
<td>May 2012</td>
<td>Dec 2011</td>
<td>May 2012</td>
</tr>
<tr>
<td>Dec</td>
<td>M (H)</td>
<td>20 (L)</td>
<td>19</td>
<td>Dec</td>
<td>M (H)</td>
<td>23 (L)</td>
</tr>
<tr>
<td>Dec</td>
<td>M (H)</td>
<td>13 (L)</td>
<td>17</td>
<td>Dec</td>
<td>M (H)</td>
<td>15 (L)</td>
</tr>
<tr>
<td>Dec</td>
<td>M (H)</td>
<td>12 (L)</td>
<td>7.8</td>
<td>Dec</td>
<td>M (H)</td>
<td>16 (L)</td>
</tr>
<tr>
<td>Dec</td>
<td>M (H)</td>
<td>88 (L)</td>
<td>7.8</td>
<td>Dec</td>
<td>M (H)</td>
<td>88 (L)</td>
</tr>
</tbody>
</table>

*Common root rot

Table 2 Available nitrogen (kg/ha) at seeding time after different cultivation treatments

<table>
<thead>
<tr>
<th>Wunkar</th>
<th>0-10 cm</th>
<th>10-30 cm</th>
<th>Total</th>
<th>Wunkar</th>
<th>0-10 cm</th>
<th>10-30 cm</th>
<th>Total</th>
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<tr>
<td>EW</td>
<td>21</td>
<td>34</td>
<td>55</td>
<td>EW</td>
<td>21</td>
<td>68</td>
<td>89</td>
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<tr>
<td>LW</td>
<td>21</td>
<td>26</td>
<td>47</td>
<td>LW</td>
<td>13</td>
<td>45</td>
<td>58</td>
</tr>
<tr>
<td>NT</td>
<td>18</td>
<td>24</td>
<td>42</td>
<td>NT</td>
<td>12</td>
<td>42</td>
<td>54</td>
</tr>
</tbody>
</table>

EW=early worked, LW=late worked, NT=No-till

Table 3 Yield, protein and nitrogen use results from 2012 Wunkar site

<table>
<thead>
<tr>
<th>Tillage</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
<th>N use* (kg/ha)</th>
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<tbody>
<tr>
<td></td>
<td>SCP Flat</td>
<td>VP Flat</td>
<td>Ave Flat</td>
</tr>
<tr>
<td>EW</td>
<td>0.93</td>
<td>1.00</td>
<td>0.96</td>
</tr>
<tr>
<td>LW</td>
<td>0.71</td>
<td>0.68</td>
<td>0.70</td>
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<tr>
<td>NT</td>
<td>0.72</td>
<td>0.66</td>
<td>0.69</td>
</tr>
<tr>
<td>NTH</td>
<td>0.77</td>
<td>0.80</td>
<td>0.79</td>
</tr>
<tr>
<td>Ave</td>
<td>0.78</td>
<td>0.79</td>
<td>0.79</td>
</tr>
</tbody>
</table>

SCP = Sown Cereal Pasture of Marion oats, VP = Volunteer Pasture
EW=early worked, LW=late worked, NT=No-till, NTH=No-till with higher inputs

Bipolaris inoculum levels at the Wynarka site after Bevy rye averaged 88 pgDNA/g soil in December compared to 18 pgDNA/g soil following the volunteer pasture. By seeding time these levels had grown to an average 163 pgDNA/g soil after the Bevy rye, and only 35 pgDNA/g soil after volunteer pasture across 32 soil tests (Table 1). As the wheat crop ripened in mid-October white heads marked the cereal rye strips, resulting in a 33% yield loss compared to the volunteer pasture. It was also noted that the root loss measured from rhizoctonia averaged 99% from these Rye areas compared to 24% from the volunteer pastures, suggesting a link between the disease effects. Generally cereal rye is used as an important break crop in the Mallee to improve soil health, and bipolaris is generally not a strong consideration when planning rotations, so it was quite unexpected that this problem arose, and suggests that further work needs to be done in this area. As in the previous years’ trial (Part A), the early tillage treatments had little impact on the levels of rhizoctonia inoculum in the soil come seedling time, but did result in large differences in available nitrogen to 30 cm depth. Early worked areas last year had between 13-35 kg/ha higher N availability at seeding compared to the No-till areas (Table 2), and 23-27 kg/ha higher N at seeding in 2011.

Yield results from the Wynarka site last season were inconsistent between tillage treatments across replications, and there was no clear advantage to cultivation. However, in 2011 the Wynarka results consistently showed a yield benefit from No-till over early working across the site. In both years these sites were well set up for No-till with summer and autumn chemical weed control as required.

Results from Wunkar in 2012 (130 mm GSR) showed a consistent yield advantage for the early worked plots (Table 3). This may have been due to several reasons. The first is that this paddock did not have any chemical summer weed control, but rather just grazing of summer weeds. Last year many Mallee farmers commented on the large difference in crops between those paddocks having excellent summer weed control that conserved moisture, and those that didn’t. Any No-till farmer knows that one of the keys to success is having good summer weed control. My feeling is that many livestock farmers tend to use grazing more for summer weed control, which is a logical compromise for getting some valuable feed as well as keeping summer growth down to a manageable size. However, if you are not killing the plants, roots and all, then you will be compromising the potential of your following crop and certainly diminishing your chances of success with No-till seeding into this ground.
The second is that while we are keen to promote No-till seeding over cultivation where it may lead to potential erosion issues (both sites, particularly Wynarka, suffered wind erosion from the worked areas), the reality is that there are some seasons and situations where cultivation may prove to be advantageous, particularly in relation to the availability and timing of N mineralisation.

In 2011 (Part A) at the Wynarka site the No-till plots started with around 20-25 kg less N available at seeding time, but then appeared to mineralise far more N throughout the growing season, leading to higher yields and resulting in about 20 kg/ha more N being found and used at harvest. This extra N mineralisation (also measured in CSIRO trials) is attributed to the higher microbial activity that occurs in No-till systems throughout the growing season as the crops need it, predominantly when the soil is moist and the temperatures are warmer. In 2012, however, this extra N boost in No-till systems did not appear to kick in as well, possibly due to the cold winter and almost complete lack of rainfall after mid-August to the end of the season when increased microbial activity normally occurs. This appears consistent with the generally low proteins from continuous cropping systems across the region. More work needs to be done to better understand these microbial and nutritional relationships within various farming systems and seasons.

The No-till High (NTH Table 3) plots were designed to try and account for the extra nutrient mineralisation at seeding from cultivation. In 3 of the 4 trials over the 2 years, while the farmer applied an extra 25-50 kg/ha of fertiliser, this only equated to an extra 4.5-9 kg/ha N which generally showed no consistent advantage. However, at Wynarka in 2012 the No-till High received an extra 23 kg/ha N, which averaged a 0.4 t/ha yield increase over No-till and 0.8% higher protein across the loamy sand main trial area. These yield and protein benefits were higher in the plots suffering from bipolaris. While I would like to see more work done in this area, I feel that farmers starting No-till from a more traditional base with pastures may benefit from extra N, unless coming off a good legume pasture.

Differences in protein levels between the soil types in dune swale landscape at Wunkar were high (Table 3). If achieving APW swale then there may well have been a good case for harvesting and marketing the flats separate to the sand hills, to help maximise returns.

**What does this mean?**

To maximise potential success with No-till into pasture ground, based on results from these 2 years of trials, other mallee research and anecdotal observations, I recommend the following:

- **Early grass removal from pasture phase is better than just sprayspraying.**
- **If using sown cereal pastures, choose disease resistant varieties.**
- **Use chemical summer weed control that kills weeds and optimises moisture conservation, rather than just relying on grazing management.**
- **Keep autumn a weed free zone, not allowing for disease build up on volunteer growth.**
- **Use proven No-till seeding systems with good breakout pressure, deeper working narrow points, good seed and fertiliser placement and presswheels creating a water harvesting furrow.**
- **Sow early as practical before soil temperatures decline, with adequate N, P and Zn.**
- **Don’t despair if No-till looks poor early, as generally nutrient mineralisation later in the season as the crops require it will be advantageous.**

My observations are that farmers that have been successfully No-tilling in more intensive cropping systems with the right set ups and management generally have more success with No-till into pasture ground. Farmers that are generally coming from a more traditional crop pasture situation will have bigger challenges in trying to move toward best practice No-till management after pasture.

Remember, No till systems will help protect your paddocks from potential erosion and will help increase biological activity in the soil that will improve crop nutrition in the long term.

**Acknowledgements**


Funding through Grain&Graze2, GRDC and Caring for our Country.
Key messages

• Soil quality is currently being measured in grain-producing areas across Australia.
• This monitoring program and associated website www.soilquality.org.au is providing the Australian grains industry with a unique resource on soil quality including soil biology, chemistry and physics.
• Each grower’s soil quality information is housed on the soil quality website and workshops can provide training to access and interpret this information to support improved soil management.
• For more information contact the soil quality champion for South Australia ann.mcnneill@adelaide.edu.au

What is the Soil quality website?
The soil quality website (www.soilquality.org.au) provides a unique, interactive resource to the Australian grains industry on soil quality, including soil biology as well as soil chemistry and physics. The web site is designed to allow growers and advisers to benchmark paddocks against a range of values for the local catchment and region, as well as against expert opinion. This information will aid growers and advisers to determine if they are heading in the right direction with their systems and practices, and will support decisions to improve soil management practices.

The National Soil Quality Monitoring Program
The Soil Quality Monitoring Program initially provided Western Australian soils data for the website and is expanding to include grain-producing areas across Australia. This has been made possible by linking into the DAFF program to assess Soil Carbon Stocks in agricultural land and accessing soil samples for additional quality measurements. Soil quality ‘champions’ have been sourced in each state and are charged with co-ordinating activities to facilitate the collection of soils data, and to raise awareness of the soil quality website and what it offers. The champions to contact in South Australia are Lynne Macdonald and Annie McNeill.

The website will give growers and advisers across Australia access to regionally specific data on soil biological, chemical and physical constraints to production. The website currently has benchmark data from red-brown earths on Eyre Peninsula and the mid-north regions of South Australia. Some of the biological, chemical and physical indicators of soil quality measured as part of the Monitoring Program are shown in Table 1, which also lists how each indicator can be related to soil quality and production. Whilst some of these indicators may currently inform agronomic planning by growers and advisers, many are not used. Greater awareness of why they should be considered can be gained by engaging with the soil quality website.

Benchmarking soil quality
The information on the website is provided in a number of formats including a ‘traffic light’ snap shot where each measure of soil quality is partitioned into ranges that are assigned green, amber and red status. This makes it possible to highlight the main indicators of concern in relation to soil quality and grain production. The traffic light system is based on expert panel recommendations for critical values of each indicator housed in the website. Where there is sufficient data recorded on the website users can also benchmark their soil quality results against that of other producers on similar soil types in their catchment or region (as shown in the Western Australian example in Figure 1). More data is needed for South Australia to allow growers across the regions to do this.

A screen shot from the soil quality website (Figure 1) illustrates there is enough data for a grower from Young River, Western Australia to be able to benchmark their own level of the soil quality indicator ‘Soil pH’ with the range for all sites in their catchment (left) or region (right). The graph compares the grower’s value (dot) with the range for all sites in the catchment or region (open rectangle) and with the range of the middle 50% of sites in the catchment or region (filled in box).

Workshops and demonstrations
Soil health workshops can be organised by liaising with your State soil quality champion. The goal is to enable groups of growers and advisers to understand and interpret the data being generated, so that they can use it to improve productivity on-farm. Computer and web training can show individuals how to access and examine their own data via the web site. This training will empower growers to make better-informed management decisions with respect to production and longer-term soil sustainability.

Fact sheets and calculators
The soil quality data on the web site is supported by a wide range of fact sheets and some simple calculators. Fact sheets generally relate the soil quality indicators to productivity and management options within certain environments or States.
Some provide information on a specific soil quality indicator (e.g. microbial biomass), while others give instructions on how to measure and interpret some soil analysis results (e.g. bulk density). There are also a number of fact sheets introducing different farm management strategies for those farmers coming to terms with difficult soil properties, such as compaction or waterlogging. While these fact sheets give a concise introduction to each topic, more detailed information that advisers might require can be gained through the “Further Reading and References” section at the end of each fact sheet. The simple calculators available on the website enable ‘what if’ scenarios to be tested to highlight management decisions that can improve soil quality. They are designed to give a basic understanding of different strategies that may present options for management change on the farm and are useful in determining the soil quality value, and sometimes the economic implications, of a change in paddock management (e.g. green/brown manuring, controlled traffic), effectiveness of liming products, potential wheat yield based on rainfall, or simply to determine the potential to alter soil carbon.

**Where to next?**

The website needs to continue to be populated with reliable data. This requires that stakeholders such as advisers and grower groups work together with the State soil quality champions and partners to ensure suitable projects for soil sampling and indicator analyses are funded. The website will then grow and provide an invaluable long term resource for Australian grain growers to monitor and benchmark their soil quality over time and to learn about options for ensuring quality is maintained and grain production is sustained.

**Contact details**

Ann McNeill  
The University of Adelaide School of Agriculture, Food & Wine, Waite Campus, Glen Osmond SA 5064  
Phone 08 83138108  
Email ann.mcneill@adelaide.edu.au