SOUTHERN AUSTRALIA FOCUS

COVERING CROPPING SYSTEMS OF SOUTHERN NSW, VICTORIA, TASMANIA, SOUTH AUSTRALIA & WESTERN AUSTRALIA

THE RESEARCH VIEW

Better management of variable soils

By Anthony Whitbread[1], Rick Llewellyn[1], Bill Davoren[1] and Ben Jones[2]

Farmers have long been aware that crop performance within paddocks shows enormous spatial variation, especially in the cropping regions of the Mallee. With the advent of tools to detect soil variability such as EM38, yield monitors and variable rate fertiliser spreaders, farmers are now in a position to better manage variation.

Because relative yield differences between zones delineated on the basis of subsoil constraints (inferred from electromagnetic induction) are not constant, a combination of field results and crop simulation modelling has been used to determine the likely longer-term economics of zone management.

This article outlines an approach where representative soils within the zones of like yield performance were characterised for their plant available water capacity (PAWC) and sub-soil chemical constraints. Crop-soil modelling tools (APSIM Agricultural Production Systems sIMulator) were used to simulate the potential yield of zones as well as in-season predictions of crop growth.

Bill Davoren, CSIRO, collecting soil cores.

DOING THE RESEARCH

Using the information collected in the Mallee Sustainable Farming (MSF) Reap-

...ii ▷

Consultants' Corner

Consultants' Corner is an initiative by *Australian Grain* highlighting current GRDC-funded research with a particular focus on the commercial implications of adopting cutting-edge research.

◁i…VARIABLE SOILS

ing Rewards project, four sites were selected (Bimbie, Carwarp, Pinnaroo and Loxton). At each site in 2006 the sites were intensively soil sampled for the analysis of chemistry and texture (0–10, 10–20 and then 20 cm increments to 110 cm depth). An EM38 survey, which measures the conductivity of the soil to about 110 cm was used to create three EM-based soil classifications for each paddock using an isocluster technique.

The soil cores were assigned to the soil classifications in which they were located and the results presented are averages of the cores falling into these zones. In order to characterise the plant available water capacity (PAWC) of each zone, the drained upper limit (DUL) was determined at a point within each zone by wetting up soil to saturation and allowing it to drain and then measured.

Crop lower limit (CLL), was also determined for each zone using the soil moisture measured at the harvest of wheat crops in 2006 (nine cores across the three soil classes) and in 2007 (27 cores across the three soil classes).

The lowest soil moisture value measured in the two seasons was used as the CLL. Using crop modelling and the long term records sourced from a nearby weather station, a simulation of wheat growth in each year for the period 1957 to 2006 was undertaken with APSIM.

The simulations are reset each year so that starting soil N and organic matter remain the same in all years. Starting soil mineral N was assumed to be the same (52 kg N per hectare to 110 cm) for each soil class in the paddock. The effects of rainfall, evaporation, drainage and water extraction by the crops were all calculated by the model.

Wheat (cv. Yitpi) was sown between April 25 and July 15 and sowing within this period was triggered by 10 mm rain over five days and the soil profile had to contain at least 10 mm of available soil water.

FIGURE 1A: Carwarp EM map, 2006 barley yield and 2007 wheat yield maps showing paddock elevation

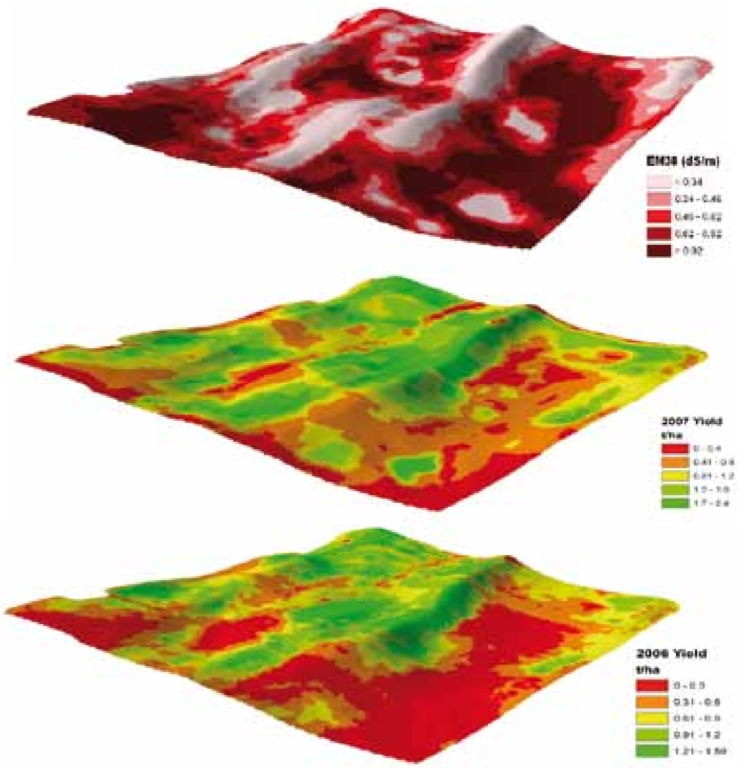
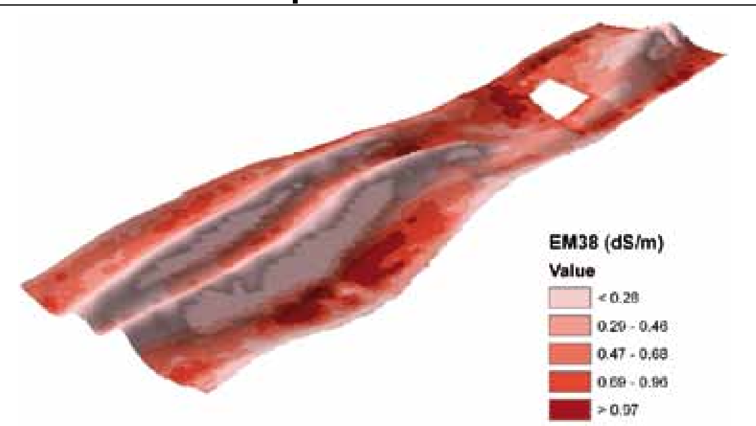


FIGURE 1B: Loxton EM map



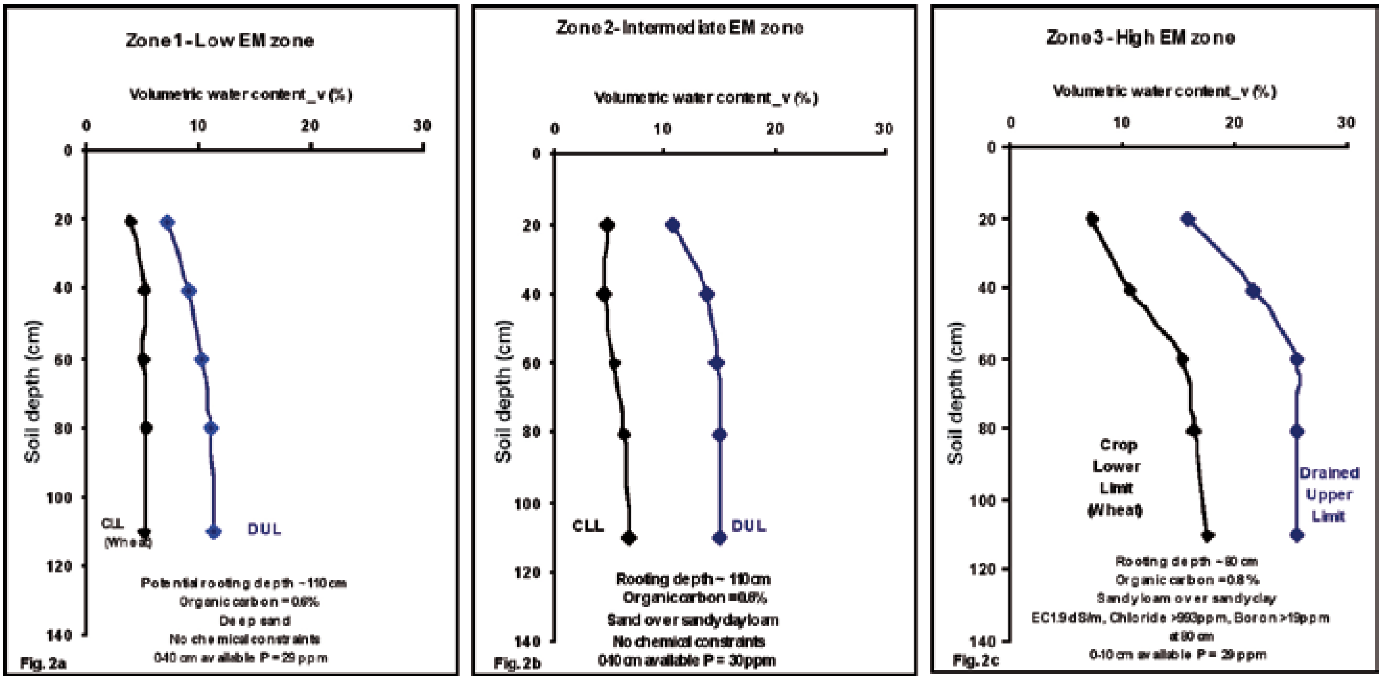
Mapping soil property boundaries

The use of EM38 to differentiate soil boundaries based on the sensing of subsoil characteristics such as clay content and salt concentration has been shown by the Reaping Rewards work as an effective method for zoning Mallee paddocks into management zones of similar yield potential. An example of this is shown for the Carwarp paddock where the EM38 measurements correlate well with the 2006 and 2007 yield monitor data (Figure 1a) and for Loxton (Figure 1b).

These maps provide a good example of how EM can be used to help identify areas of the paddock with differences in yield potential that can't easily be identified by elevation. The 2006 and 2007 seasons – where a dry finish meant that subsoil constraints were very important factors – are examples of seasons where yield maps

Anthony Whitbread, CSIRO.

FIGURE 2: The characterisation of the crop lower limit (CLL) and the drained upper limit (DUL) for the Loxton soil profiles in the zones defined as containing low (Figure 2a), moderate (Figure 2b) or high (Figure 2c) subsoil chemical constraints



that are unaffected by other factors such as frost, disease and weed patches can be expected to align reasonably well with EM maps.

It should be noted that a strong relationship between EM zone and yield will not occur in every season-type. For example, in some seasons late rains make subsoil constraints and the availability of stored moisture less critical to crop yield and less yield variation across the paddock could be expected.

Soil characterisations for each zone – Loxton example

Within each zone the soil properties, particularly soil texture and the depth to sub-soil constraints – determine how water behaves in the soil profile and how much is available for plant uptake or evaporation. In the Loxton environment the sandy textured soils (usually low EM38 values) have deep profiles and no surface or sub-soil chemical constraints. In heavier textured soils, particularly where sub soil constraints exist, plant available water only resides in the layers near the surface.

While the plant available water capacity may be high in these surface layers, evaporation losses are also higher. In the low EM (sandier) soils the soil water content at the crop lower limit was low, implying that the crop used water at depth and their were no subsoil constraints present in the soil that limited root growth.

The soil moisture content at DUL was also lowest in these sandier textured soils, although it does increase with depth as the clay content increases. In contrast, soils with high EM38 values, had a subsoil constraint that limited root penetration and water uptake.

The CLL in these soils at depth was higher than the corresponding low zone soils. The chemical constraints increased with depth and soil moisture could not be extracted by roots from the profile (Figure 2c). DUL was also highest due to the increased clay content of the soils in these constrained zones.

The simulation of wheat growth

To enable yield potential to be determined in the zones over a wide range of season types, representative soils in all paddock zones were characterized and wheat yield simulations run using the APSIM crop model. The simulated yields from

...iv ▷

TABLE 1: Simulated wheat grain yield (with a sowing N application of 30 kg per hectare) within zones surveyed as containing low, moderate and high subsoil constraints for all sites over the period 1957 to 2007

			Probability of yield		
	EM38 zone	Median yield (t/ha)	Less than 1 tonne	1–1.5 tonne	More than 1.5 tonne
Bimbie	Low	1.42	0.29	0.29	0.42
	Moderate	1.43	0.35	0.19	0.46
	High	0.60	0.67	0.12	0.21
Carwarp	Low	1.52	0.27	0.21	0.52
	Moderate	0.90	0.54	0.08	0.38
	High	0.58	0.62	0.08	0.31
Loxton	Low	1.51	0.08	0.38	0.54
	Moderate	1.58	0.29	0.13	0.58
	High	0.85	0.58	0.25	0.17
Pinnaroo	Low	1.42	0.37	0.17	0.46
	Moderate	1.40	0.38	0.15	0.46
	High	0.98	0.52	0.10	0.38

EM38 mapping at Carwarp in Victoria's Mallee.

◁iii…VARIABLE SOILS

the sites and seasons from 1957 to 2007 showed consistently large differences in median yield between the low or moderate zones and the high EM zones. The probability of achieving low yields (less than one tonne per hectare) was also much higher in these high EM zones (Table 1).

FUTURE DIRECTIONS

Fertiliser and seed application may be varied across the zones to reduce inputs into the constrained zones and capitalise on the performance of less constrained zones by increasing inputs. The opportunities to strategically manage the zones, for example topdressing light sands in a wet year or deciding to cut/graze constrained zones at some decision point in a dry year, are management options that should be informed by facts.

These facts include the stage of the crop and time of season, plant available N and water and seasonal outlook. Modelling tools, particularly Yield Prophet, can take these factors into account and provide accurate predictions of likely yield outcomes.

Where crop performance is consistently poor, alternative land uses may be more profitable and result in other benefits such as increased ground cover or better fodder reserves.

Acknowledgements: This work was funded by CSIRO and GRDC. The support of the participating farmers at each site is gratefully acknowledged. Dr Roger Lawes, CSIRO Sustainable Ecosystems is thanked for his helpful comments on this article.

[1]CSIRO Sustainable Ecosystems, South Australia.
Ph: 08 8303 8455
E: anthony.whitbread@csiro.au
[2]Mallee Focus, Manangatang, Victoria
E: ben@malleefocus.com.au

■

THE COMMERCIAL VIEW

NEW N TOOL UNLOCKS YIELD POTENTIAL FOR MALLEE FARMS

A new decision-making software tool for Mallee farmers and advisers is designed to unlock key questions around nitrogen fertiliser application – when, where and how much to apply to get best results.

The Zonal N Management Tool is a collaborative project between Ben Jones from the agronomy consulting business Mallee Focus, Mallee Sustainable Farming Group, and CSIRO Sustainable Ecosystems in Adelaide. This project is also supported by the Grains Research and Development Corporation.

The tool was developed from crop modelling through APSIM using simulations of wheat crops in Mallee paddocks at Carwarp, Euston, Loxton and Pinnaroo.

Ben says the software tool is based on the principle of first applying units of N to areas where the best response will be achieved.

"Under traditional agronomy, grain growers would come up with a target yield and then put on as much nitrogen as required to achieve that yield. But, traditional agronomy doesn't provide a guide to other options, particularly if you can't afford to put on that amount of N or are uncertain about seasonal conditions. So under current systems, it has been difficult to apply N to different soil zones.

"The tool has five sections for input including rainfall, economic conditions, nitrogen setting, paddocks and zones. It calculates how much N to apply on each zone by allocating units to the zone with the highest average response.

"It also has an automatic and manual setting. In the automatic mode, the tool works out where the N is best applied given the season expected. N is applied at an average rate until it is no longer profitable.

"The manual mode allows for grain growers to make changes to N application and to gauge how the crop's end yield could be affected," Ben explains.

Ben's role with developing the tool has also involved practical validation, or as he calls it, the 'sensibility test', to check that information the tool is providing on N and soil response is comparable with his experience out in the field.

"APSIM was developed in Queensland for the deep clay soils of the Darling Downs and was also tested in the sandy soil regions of Western Australia.

"In the Mallee, crop production is not only influenced by plant available water content, it can be more about evaporation from the top 10–20 cm of soil so there has been a lot of work involved to improve the simulation of soil type differences in the simulation models."

Ben says he had been able to use Anthony Whitbread's work on finding long-term strategies (see main article) and adapt it in the tool to focus on year-to-year management decisions, particularly with changing economic conditions and inputs.

"The tool is easy to use and will help growers understand how different seasons and zone management will impact final yields," he said.

Ben has been able to put the tool to practical use on his family property, which was EM38 mapped in April 2007. The data produced now is a crucial part of crop management.

"We had some idea of the soil type differences already but the EM map better defined the areas and picked out a few surprises. It also gave us a better idea of just how constrained some of our heavier soil types were. This made us realise some paddocks were capable of greater production and we have managed them more intensively since.

"This year we used the EM map to pick out parts of a block that were worth sowing once it started getting dry after the seasonal break. We left the constrained parts fallow and were hoping we'd regret it because the season would improve. But we had a dry spring here until late September and those crops wouldn't have come to much.

"This coming year grain prices are likely to be lower and we really only want to be sowing parts of the farm that will give a guaranteed return, without creating agronomic headaches in future. The EM map will be a key part of deciding which paddocks to sow and which to keep as 'opportunities'."

A free download of Zonal N Management is available at www.malleefocus.com.au/tools