Farming to soil type in the Mallee to improve water use efficiency and reduce risk

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Key messages:

- A new field research site at Karoonda has been established to further explore opportunities for soil-specific management to increase water use efficiency and reduce risk.
- Large differences between zones in 2009 yield and pasture/biomass production indicate potential for zonal management strategies to improve profitability.

Aims:

- In paddocks with very high soil and WUE variability, identify where inputs (and cropping) can be profitably reduced (or increased) in zones based on season-reactive and strategic approaches.
- To identify smarter breaks and phases for multiple rotation benefits.

Background:

Over the past 10 years, GRDC funded work conducted by MSF and its partners has demonstrated highly water use efficient intensive cropping systems. This has led to large increases in the adoption of more intensive cereal production. However, there still remain many opportunities to improve average whole-farm water use efficiency (WUE) across the Mallee region because these intensive cropping systems have several challenges (e.g. grass weed problems, disease, high fertiliser costs, need to reduce exposure to downside risk). A new phase of work continues the emphasis on field experimentation by implementing core site trials at Karoonda and Ouyen (the trials at Ouyen to be established in 2010) as well as utilising crop-soil modelling to test the results over a range of soils and seasons.

About the trial:

Using the technologies tested in the 'Reaping Rewards' project, EM38 and soil testing have been used to locate: trial (1) the new 'Continuous Systems for Soils' trial; and (2) break crop trial across a dune-swale. Both trials were established using best practice no-till systems including narrow points, press wheels with all stubble being retained.

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Trial 1- Continuous systems for soils: In 2009, we established 8 new treatments (T1, volunteer pasture and T2-T8 wheat) replicated 4 times in long plots that cover the maximum range in soil variation for the Mallee; from a highly constrained swale onto a sand dune. The 7 wheat treatments were established with the same inputs in 2009 so that soil attributes and crop performance could be monitored in year one to observe the impact of soil variation alone. Trial plots were ~150 m in length + 1.6m wide and sown to Wheat var. Correll on the 15 May 2009 at 70 kg/ha using narrow points and press wheels on 23 cm spacings. Urea was sown below the seed @ 35 kg/ha and DAP + Zn 2% @ 50 kg/ha with the seed. At harvest each plot was split into 20m sections and harvested individually to enable more detailed analysis of the crop response to location in the landscape. Plant available soil N and P concentrations levels were analysed on soil samples collected from several points in the dune-swale.

Trial 2- Break Crops: In mid May 2009, we established 5 break crops (to be followed by wheat in 2010-2012), 5 wheat treatments (sown to break crops in 2010) and a wheat only control (Table 1). Planting rates and fertiliser applications were the same across all soil types (Table 2). Plot size was 1.6 m x 40 m and all treatments were replicated 4 times and laid out as a randomised complete block designed experiment at 3 positions on a dune – swale, i.e. sand, midslope and flat. The emergence of mustard (Treatment 2) at the midslope and dune sites was very poor and mustard was resown on August 4 but again failed to emerge. Cereal rye was either grown to maturity for grain (T3) or cut on 4 August (T4, to simulate a late grazing) and allowed to regrow until maturity for grain harvest.

Table 1. Break crop treatments imposed in 2009 and proposed treatments in 2010-2012

Treatment	2009	2010	2011	2012
1	Legume (peas)	Wheat	Wheat	Wheat
2	Brassica (mustard)	Wheat	Wheat	Wheat
3	Cereal Rye – grain	Wheat	Wheat	Wheat
4	Cereal Rye– grazed	Wheat	Wheat	Wheat
5	Volunteer pasture	Wheat	Wheat	Wheat
6	Wheat	Legume (peas on flats/lupins on dune)	Wheat	Wheat
7	Wheat	Brassica (Forage canola)	Wheat	Wheat
8	Wheat	Cereal Rye – grain	Wheat	Wheat
9	Wheat	Cereal Rye– grazed	Wheat	Wheat
10	Wheat	Volunteer pasture	Wheat	Wheat
11	Wheat	Wheat	Wheat	Wheat

Table 2. The following inputs were applied to the treatments established in 2009

Treatments	Crop/Variety	kg/ha	Fertiliser
Legume	Peas cv. Kaspa	100	DAP + Zn 2% @ 50 kg/ha
Brassica	Mustard cv. Sahara	5	DAP + Zn 2% @ 50 kg/ha plus Urea 35 kg/ha
Cereal – grain	Cereal rye cv.Bevy	80	DAP + Zn 2% @ 50 kg/ha plus Urea 35 kg/ha
Cereal – hay/grazing	Cereal rye cv. Bevy	80	DAP + Zn 2% @ 50 kg/ha plus Urea 35 kg/ha
Volunteer pasture	Volunteer Pasture	nil	Nil
Wheat (x 6)	Wheat cv. Correll	70	DAP + Zn 2 % @ 50 kg/ha plus Urea 35 kg/ha

Assessments:

The collection of data at the trial site included:

- EM 38
- Pre-sowing soil tests –chemical analysis, plant available water, microbial nutrient and soilborne pathogen analyses
- Plant Biomass on 27 July (late tillering), 23rd September (anthesis)
- Maturity, plant biomass, grain yield and protein concentration
- Daily rainfall and max/min temperature (hill and flat)

Results:

Rainfall: Sowing of both trials took place on 15 May after 38 mm of rain had fallen between 25 April and 2 May. There had been little rainfall in the months prior to the season break resulting in very little stored soil moisture at sowing (Fig. 1). Total growing season rainfall (from sowing to October) was 192 mm which is between a decile 5 and 6. The long term average growing season rainfall (April to October) is 237 mm. In the period from 12 July to 23 August, crop growth and yield potential was reduced by low rainfall (~18mm) and warm daily temperatures. From 24 August, there was good rainfall and finishing conditions.

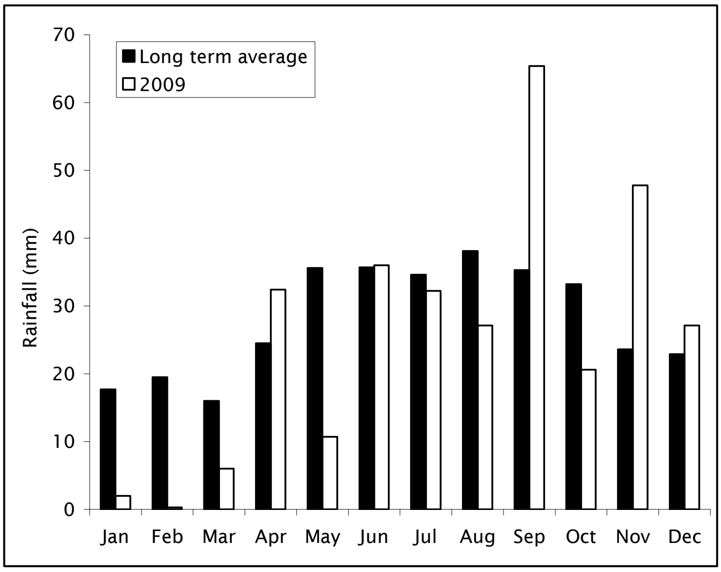

Figure 1. Monthly rainfall for the Karoonda trial site.

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Trial 1- Continuous systems for soils: Soil mineral N was high in the flats and moderate in the dune areas (Table 3). Similarly, N supply potential and microbial biomass (MB) levels were higher in soils from flats (e.g. MBN = 46 to 61kgN/ha) compared to that in midslopes and dune area soils (MBN = 23 to 27kgN/ha). As expected, EC, B and Cl reached very high readings at depths greater than 40 cm in the soils from the flats (data shown in Whitbread et al., this compendium). While emergence of the crop was good, there was a large difference in plant population measured across the landscape with the dunes having 86 plants/m^2 compared with 131 plants/m^2 on the flats (data not shown). By late tillering, there was also more biomass on the flats compared with the sands, with this difference smaller by anthesis. Grain yields were lowest (0.8-1.0 t/ha) at the extremes of the trial (flats and dunes) and highest in the mid-slopes. Assuming similar evaporation at all positions (this assumption will be tested further given the differing cover levels and soil textures), WUE was calculated to be highest at the midslope positions and lowest on the dunes and flats. Further characterisation of the soils this year will confirm the water balance of the various soils across the trials.

Table 3. Karoonda Continuous systems Trial: Data summary

Position	EM38 EMv	[1]Total Moisture content 0-1m	Soil Nitrate 0-1m	Biomass	Biomass	Yield	Grain Protein	[2]WUE
	(ms/m)	(mm) *May 12*	(kg/ha) *May 12*	(t/ha) *July 7*	(t/ha) *Sept 23*	(t/ha)	(%)	kg grain/mm water transpired
1 Dune	39	79	39	0.33	2.3	0.8	11.0	10
2	42	82	39	0.52	2.6	1.2	10.9	14
3	56	107	52	0.66	2.5	1.4	12.3	17
4	104	174	64	0.64	3.8	1.5	11.6	18
5	144	196	100	0.98	3.3	1.1	13.2	13
6	133	193	105	0.78	3.0	1.2	14.4	14
7 Flat	138	220	203	0.89	2.9	1.0	15.9	12

Note: [1]Crop lower limit (0-1m) on the sand is estimated to be ~71mm and on the flat ~201 mm resulting in between 9 and 19 mm of plant available water at sowing.
[2]Water Use Efficiency is calculated as [grain/(change in sw between harvest and sowing + growing season rainfall-evaporation)]. Runoff and drainage was assumed to be nil, and soil evaporation was calculated to be 110mm on all soil types.

Trial 2- Break Crops: Biomass production by 28 July was similar for all crops across the dune–swale, but biomass of the pasture on the flats was much greater than on the hill or midslopes (Table 4). This was due to a difference in species composition with the flats being dominated by annual ryegrass and the sandier soils dominated by annual medics. The grain yield of peas was 0.5 t/ha over all landscape positions, while the un-cut rye grain yield on the hill and midslope were more than double that on the flats. The effect of cutting the rye resulted in the grain yield being about half of the un-cut treatments (Table 4). Mustard failed to germinate on the sandier soils of the midslopes and dunes, but performed well on the flats. Wheat grain yields on the flats and mid-slopes were similar to the yield achieved in the WUE trial, however grain yields on the dune were higher. This is probably due to the aspect of this site affording it the crop more protection from wind.

Table 4. Biomass cuts and grain yields of break crops, cereal and volunteer pasture treatments

	Rye 'grain'	Rye 'cut'	Peas	Mustard	Wheat	Pasture
	Biomass cuts 28 July (t/ha)					
Dune		1.58	0.44	Failed	0.74	0.62
Mid		1.72	0.48	Failed	0.67	1.21
Flat		1.58	0.58	0.45	0.90	2.28
	Grain yield (t/ha)					
Dune	1.4	0.7	0.5	Failed	1.3	
mid	1.5	0.8	0.5	Failed	1.5	
flat	0.6	0.4	0.5	0.5	1.1	

Note: Wheat biomass is from cuts in treatment 6 and the wheat grain yields are the mean of all wheat treatments planted in 2009 (T6-T11).

Future Directions:

In 2009, the main aim of the 'Continuous systems for soils trial' was to collate baseline information about the variation in soil (fertility, water holding capacity, constraints) and its interaction with crop growth. For 2010-2012 treatments options have been discussed with the Karoonda MSF site advisory group and are presented in Table 5. Treatments 3 toT5 will remain as continuous wheat while the selection of the cereal in T6 or a cereal/sprayed fallow in T7 being determined by season.

Table 5. Treatments for the 'Continuous systems for soils trial' 2010-2012

Treatment	Description
1	Volunteer winter pasture in rotation with cereal-phase 1
2	Volunteer winter pasture in rotation with cereal-phase 2
3	Continuous cereal – [1]even rate fertiliser.
4	Continuous cereal – [2]variable rate fertiliser.
5	Continuous cereal variable rate fertiliser + within season management strategies assisted by using forecasts and decision tools (topdressing, cutting for hay, forward selling decisions).
6	Continuous cereal variable rate fertiliser + opportunity cereal breaks[3] with time of sowing, crop type and variety aided by forecasts and decision tools.
7	Continuous cereal variable rate fertiliser + opportunity cereal breaks or sprayed fallow with decisions aided by forecasts and decision tools.

(Note: [1]even rate fertiliser level suited to the average yield potential and soil nutrient content of zones. [2]Variable rate fertiliser to match zone-based yield potential and zone-based soil nutrient content. [3]Cereal breaks could include cereal rye, barley, wheat, oats, triticale).

In the break crop trial, the failure of the mustard on the midslope and dune trials resulted in a bare fallow throughout 2009 which means that the wheat response to this break has now been compromised. For the brassica breaks in 2010, a forage canola will be trialed. The use of field peas on erosion-prone dunes is not good practice due to the poor cover that pea residues provide post-harvest and in 2010, peas will be replaced by lupins. In general, soils from all zones showed higher concentrations of Rhizoctonia bare-patch pathogen DNA, whereas the DNA levels for Take-All and *Pratylenchus* sp. were below detection to low-risk levels only. The effect of the break treatments on soil pathogens, particularly Rhizoctonia is also being monitored.

Who's Involved:
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