

## Technical Bulletin #22

# Implementing the Mallee Soil Health Monitoring Program: Phase 1 and 2



Left: Soil sampling in late summer 2011. Photo: Mallee CMA.

**This technical bulletin summarises the methodology and the results obtained during the first two years of the Mallee Dryland Agricultural Soil Health Monitoring Program. The aim of the program is to improve the region's knowledge of soil health indicators and the interaction associated with land management in the Victorian Mallee.**

The Mallee Catchment Management Authority (CMA), in partnership with Mallee Sustainable Farming (MSF) and the Victorian Department of Primary Industries (DPI), undertook this project.

### **Background**

The Mallee dryland soil resource supports 1.8 million hectares (ha) of crops annually, made up of approximately 90% cereals and 10% legumes and oilseed. It generates 80% of dryland farm income and produces up to 50% of Victoria's cereals to both domestic and export markets. A healthy soil for the purpose of dryland agricultural production in the Mallee is physically resilient, chemically fertile and biologically diverse. Declining soil health can cause significant detrimental environmental impacts and can have severe economic and social repercussions for the region.

### At a glance

- The Mallee Soil Health program monitors soil health indicators at two different levels across the Victorian Mallee;
- The 2010 and 2011 program monitored:
  - 115 focus sites within the Central Mallee Millewa, Tempy and Boigbeat land systems;
  - benchmark sites at Cowangie, Chinkapook and Kawawinna.
- Soil health indicators measured included bulk density, organic carbon, total nitrogen, available phosphorus, pH and electrical conductivity;
- The 2010-11 data will be used to develop and report against soil health benchmarks and targets, and to inform the development of the Mallee Soil Health Strategy;
- The completion of Phase 3 of the Mallee Soil Health Monitoring Program will be undertaken during 2012, incorporating sites from the remaining land systems.

Declining soil health has been recognised as a significant issue in the Mallee region for a number of years.

Following a detailed literature review of monitoring soil health in 2008, the Mallee CMA commissioned the 'Mallee Dryland Agricultural Soil Monitoring Program – Implementation Plan' to outline the framework for soil health monitoring in the dryland Mallee region. The framework outlined site selection, as well as monitoring requirements, procedures and monitoring schedules. The first phase of the monitoring framework was implemented in 2010 and the second phase continued in 2011.

### Methodology

The Mallee Soil Health Monitoring Framework involves monitoring soil health indicators at two different levels across the Mallee:

- Focus Sites are a large number of sites, proportionally positioned across the Mallee land system (Fig 1). At these sites a small number of key soil parameters are monitored through time. The sites used as Focus Sites coincide with sites monitored under the Soil Erosion and Land Management survey;
- Benchmark Sites are a small number of intensively monitored paddocks strategically positioned across land systems and climate zones (Fig 1).

Mallee soil health monitoring is undertaken in late February – early March, corresponding with monitoring activities for the Soil Erosion and Land Management Survey. Refer to the Mallee CMA website [www.malleecma.vic.gov.au](http://www.malleecma.vic.gov.au) for information on the methodology and results of the 'Mallee Soil Erosion and Land Management Survey'.

In 2010, 77 sites located within the Central Mallee land system were monitored for the first time (Phase 1). A further 38 sites were monitored in 2011 (Phase 2). These new sites were located on the Millewa, Temy and Boigbeat land systems (Fig 1). Monitoring also continued at two existing Benchmark sites (Cowangie and Chinkapook) and a new site was established at Karawinna (Fig 1).

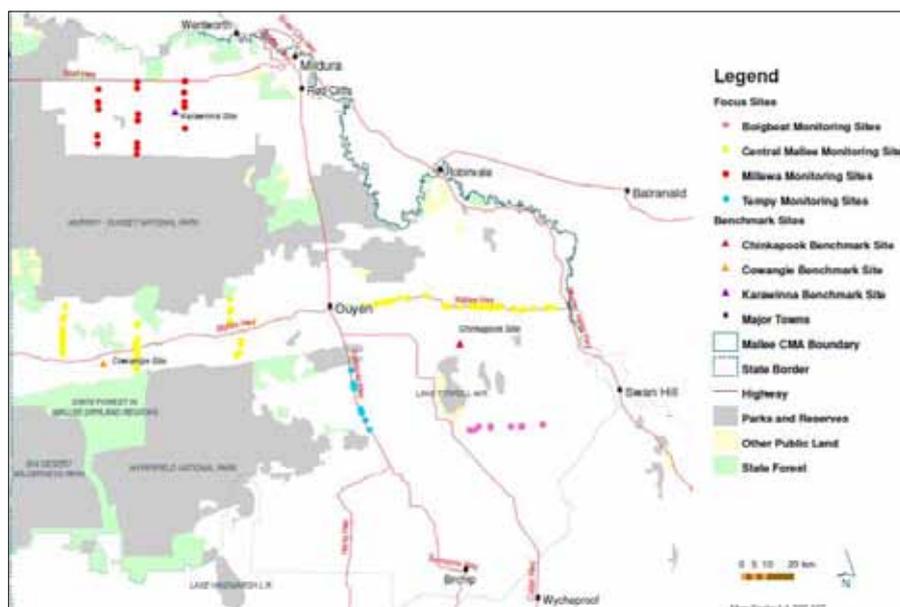


Fig 1. Location of Central Mallee Soil Health Monitoring Focus Sites and Chinkapook and Cowangie Benchmark Sites for the 2010 project delivery (Phase 1), and the location of the Millewa, Boigbeat and Temy Focus Sites and Karawinna Benchmark Site for the 2011 project delivery (Phase 1). Map: Mallee CMA.

### Focus Sites

A one hectare area was selected within each paddock as the monitoring site. Within this area soil samples were collected to measure indicators of the soil's physical and chemical health.

Physical measurements undertaken include:

- Land management
- Soil erosion potential assessments, including vegetation cover and height, soil dry aggregate; and
- Bulk density and soil texture of the 0-10cm layer.

Chemical analysis was undertaken using a composite soil sample, made up of 16 samples (0-10cm cores) collected from points within each one hectare monitoring site. Each sample was then analysed for the following chemical soil parameters:

- Organic carbon (OC);
- Total nitrogen (Total N);
- Available phosphorus (Colwell P);
- Soil pH;
- Electrical conductivity (EC).

Photographs were also captured at the four sites (Figure 2) so that bulk density could be measured. These pictures also gave a plan view of each site.



Fig 2. Two contrasting focus sites. The top site has stubble retained and the bottom site has no stubble and is cultivated. Photos: Mallee CMA.

## Benchmark Sites

At each Benchmark Site, monitoring is conducted within established monitoring sites one hectare in size. The Cowangie and Chinkapook sites have two monitoring sites (dune and swale), while at the Karawinna benchmark sites there is only one. All monitoring activities undertaken at the focus sites were also undertaken at benchmark monitoring sites, including erosion assessments. As a new benchmark site, deep soil cores were collected for the determination of bulk density, chemical properties and soil water at Karawinna. Furthermore, chemical properties were analysed separately in the following soil layers:

- 0-10 cm
- 10-30 cm
- 30-50 cm
- 50-100 cm
- 100-150 cm

The chemical properties determined for all soil samples collected at benchmark sites are given in Table 1. Additional activities undertaken at benchmark sites included the monitoring (and installation) of dip wells and monitoring of existing neutron probes.

All samples were prepared following the protocols set out in the *Mallee CMA Soil Health Monitoring Implementation Plan*, including incorporating standard soils with all samples forwarded to the laboratory. All soil samples have been included in the Victorian DPI soil archive. Archived soil samples will be analysed for biological parameters when an appropriate analytical method becomes available in the future.

## Results

### Focus Sites

#### Bulk Density

The mean bulk density of the 0-10cm layer at focus sites in the Millewa land system was  $1.44 \text{ gcm}^{-3}$ . The topsoil bulk density at focus sites in the Tempy and the Boigbeat land system were similar with average of  $1.35$  and  $1.34 \text{ gcm}^{-3}$ , respectively. Focus sites in the Central Mallee land system (measured in 2010) have an average topsoil bulk density of  $1.49 \text{ gcm}^{-3}$ .

Table 1: Soil parameters measured at Benchmark Sites.

Soil Parameter	Procedure
Organic Carbon	Acid Pre-treatment Dry Combustion (LECO)
Total Nitrogen	Acid Pre-treatment Dry Combustion (LECO)
Available Phosphorus	Colwell
Total Phosphorus	Perchloric acid digest
Electrical Conductivity	EC (1:5)
pH	pH (CaCl <sub>2</sub> )
Available Sulphur	CPC
Available Potassium	Skene
Macronutrients (Calcium, Manganese, Sodium and Iron)	Exchangeable Cations (With No Prewash)
Micronutrients (Copper, Zinc, Manganese and Iron)	DTPA Trace Elements
Boron	Hot Water
Chloride	Water Soluble

#### Organic Carbon (OC)

The 2010 and 2011 monitoring program showed that carbon levels differed markedly between land systems. The Millewa land system had the lowest average OC (0.57%), while the average OC in the Central Mallee is slightly higher (0.68%), although carbon levels were more variable in this land system (Fig 3). Soil OC levels were greatest in the Tempy and Boigbeat land systems with a mean of 0.92% and 1.09% respectively.

Bulk density and OC levels were used to quantify the total mass of carbon per hectare in the 0-10cm soil layer.

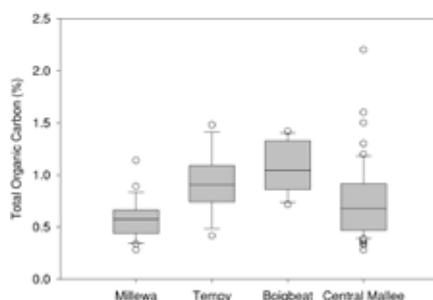


Fig 3: Percentage of total organic carbon at the four landsystems.

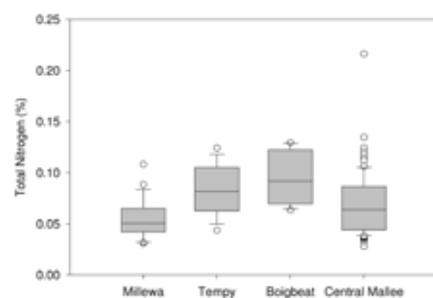


Fig 4: Percentage of Total Nitrogen at the four landsystems.

The total quantity of OC per hectare in the topsoil layer (0-10 cm) of the Boigbeat land system was ( $14.57 \text{ t C ha}^{-1}$ ) followed by the Tempy ( $12.01 \text{ t C ha}^{-1}$ ), the Central Mallee ( $10.65 \text{ t C ha}^{-1}$ ) and the Millewa ( $8.05 \text{ t C ha}^{-1}$ ) land systems. Across all land systems, OC ranged from 4.5 to 22.5 tonnes of OC per hectare.

#### Total Nitrogen (Total N)

Total N results followed a similar trend to OC, with the Boigbeat land system having the highest levels and the Millewa land system having the lowest concentrations. The average Total N levels were 0.055%, 0.070%, 0.083 and 0.097% for the Millewa, Central Mallee, Tempy and Boigbeat transects respectively (Fig 4).

Focus sites in the Boigbeat land system contained the greatest quantity of nitrogen in the topsoil with an average of  $1298 \text{ kgNha}^{-1}$ . Sites in the Tempy land system on average had less nitrogen in the 0-10 cm soil layer ( $1088 \text{ kgNha}^{-1}$ ) followed by the Central Mallee ( $899 \text{ kgNha}^{-1}$ ). The Millewa land system had the lowest nitrogen fertility with an average quantity of nitrogen in the topsoil of  $772 \text{ kgNha}^{-1}$ .

#### Available Phosphorus

In the Millewa and Tempy land systems, the average available phosphorus level was  $24 \text{ mgkg}^{-1}$ . The Central Mallee land system had a slightly higher average of  $24.5 \text{ mgkg}^{-1}$ , while the Boigbeat land



Above: Diversity of Mallee soils. Photo: Mallee Sustainable Farming.

system had the highest average available phosphorus levels of 30 mgkg<sup>-1</sup>. The variability of available phosphorus levels was greatest in the Central Mallee land system, with values ranging from 4-57 mgkg<sup>-1</sup>; however, with the exception of one value of 54 mgkg<sup>-1</sup> at one site in the Millewa, all sites had an available phosphorus level of less than 35 mgkg<sup>-1</sup> in the other three land systems.

### Benchmark Sites

The Benchmark Sites are a small number of intensively monitored paddocks, strategically positioned across the land systems and climate zones. The results of monitoring benchmark sites are documented in the *2010 and 2011 Mallee Soil Health Monitoring Reports*, available on the Mallee CMA website:

[www.malleecma.vic.gov.au](http://www.malleecma.vic.gov.au)

### Implications of the findings

The results of the 2010 and 2011 Soil Health Monitoring Program will be used to establish benchmarks for key soil health indicators within land systems. Initial

monitoring has been conducted in the Central Mallee (2010) and the Millewa, Tempy and Boigbeat (2011) land systems. Focus sites will continue to be monitored on a three year cycle. The Soil Erosion and Land Management Survey will continue to monitor the land management and soil erosion potential parameters three times annually.

Following several years of monitoring at these sites, a technical summary of the results and the implications of the findings will be produced.

### Further work

Completion of initial monitoring of focus sites will be in 2012, with baseline soil health parameters determined for sites located in the Culgoa and Hopetoun land systems. Soil health monitoring activities at benchmark sites will also continue annually.

Once benchmark levels for soil health indicators are established for all focus sites, interpretation of the historic land

management and soil health indicator data can be undertaken.

### Acknowledgements

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Field work was completed by MSF, DPI Victoria, Moodie Agronomy and the Mallee CMA. Laboratory analysis was completed by DPI Victoria.

### Further Information

The information for this bulletin has been taken from: '2010 Mallee Soil Health Monitoring' and the '2011 Mallee Soil Health Monitoring' reports. Copies of the reports can be downloaded from the Mallee CMA website.

The results of the 2010/11 Mallee Soil Erosion and Land Management Survey are summarised in the *2010/11 Mallee Soil Erosion and Land Management Survey Fact Sheet*. This Fact Sheet can be downloaded from the Mallee CMA website:

[www.malleecma.vic.gov.au](http://www.malleecma.vic.gov.au).

### References

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## Project Partners



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