# Sustainable Land Management – Hopetoun and Waitchie

**Anne Jackman (Cropfacts, BCG)**

## Aim

The Hopetoun and Waitchie Landcare Groups have established paired paddock Sustainable Land Management Demonstration Sites to look at best management practices for erosion and salinity control and compare crop and pasture growth, water use and subsequent recharge. The paddock comparisons are taking place on a lucerne paddock and an adjacent cropped paddock.

## Summary

The Sustainable Land Management Demonstration Sites in the Mallee have been established to demonstrate improved farming practices through a better understanding of crop management and water use to reduce groundwater recharge and soil erosion.

The Hopetoun and Waitchie Sustainable Land Management Demonstration Sites are using electromagnetic (EM) surveys to identify soil differences and subsoil constraints. Each site has a paired paddock of crop and lucerne pasture and intensive monitoring of soil water and plant growth is being used to compare plant water use, erosion risk and nutrition across the sites.

Best management practices for the sites are being identified and implemented.

## Background

To demonstrate and measure the potential impact of best management practices for dryland agriculture in the Mallee, six sites have been selected at Hopetoun, Manangatang, Waitchie, Carwarp, Cowangie and Murrayville which represent a range of land and farming systems. Each site is approximately 100ha in area. These sites are funded by the Mallee CMA, through the National Landcare Program.

In 2005 these sites underwent preliminary studies through EM38 mapping, soil sampling and analysis. Best management land use practise options will be implemented with on-going monitoring to measure the impact of these practices.

Measurements of comparative productivity, water use efficiency, ground cover, water use and balance, soil nutrition, soil biota, groundcover, crop biomass and yields were taken throughout the lifecycle of the crop and pastures.

BCG is responsible for the monitoring of the Hopetoun and Waitchie paired pasture and crop paddocks. DPI Victoria is responsible for the monitoring of the Manangatang, Carwarp, Cowangie and Murrayville sites.

## Methods

EM38 survey

In April both paddocks at Hopetoun and Waitchie were EM surveyed to map the soil and soil water variation across the sites. They were then soil sampled to calibrate the EM readings and give pre-sowing soil conditions in the cropped paddock.

The EM38 survey measures Electrical Conductivity (ECa) which is a combination of both soil water and salt content and is used to show different soil characteristics across a paddock. To calibrate the EM survey for water, soil electrical conductivity, boron and chloride, ten sites were soil sampled to 1.3 m depth for soil water and chemical analysis. The EM survey was repeated at the end of the season but maps are not yet available.

Monitoring

BCG monitored the paddocks throughout the season to compare soil variation with crop growth and water use. A neutron probe was used during the season to monitor changes in soil water at five depths. Ten sample sites, five on the crop paddock and five on the lucerne paddock, had neutron probe access tubes installed.

Plant populations, growth and yield were measured at each of these sites.

Erosion risk was measured post sowing and at harvest. The in-paddock monitoring included both ground cover and soil particle aggregation assessment. From both of these measures the susceptibility to erosion risk was assessed following the procedures of Leys et al. (2002).

Soil moisture characteristics were measured for the sand hill and lower slope and the APSIM crop model calibrated and used to look at crop yields and water use across the paddock on different soil types.

## Results

Rainfall

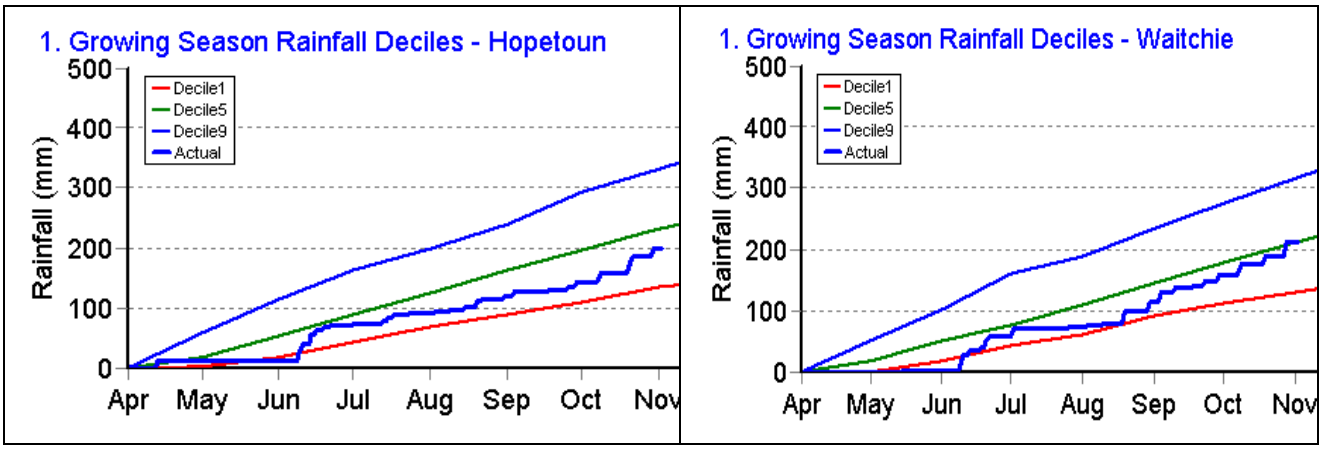



**Figure 1:** Growing season rainfall at Hopetoun and Waitchie

Growing season rainfall for Hopetoun was in decile 3, below average with 203 mm, and average for Waitchie with 212 mm, decile 5.

## Hopetoun Landcare Delivery site – EM maps, monitoring and yield results

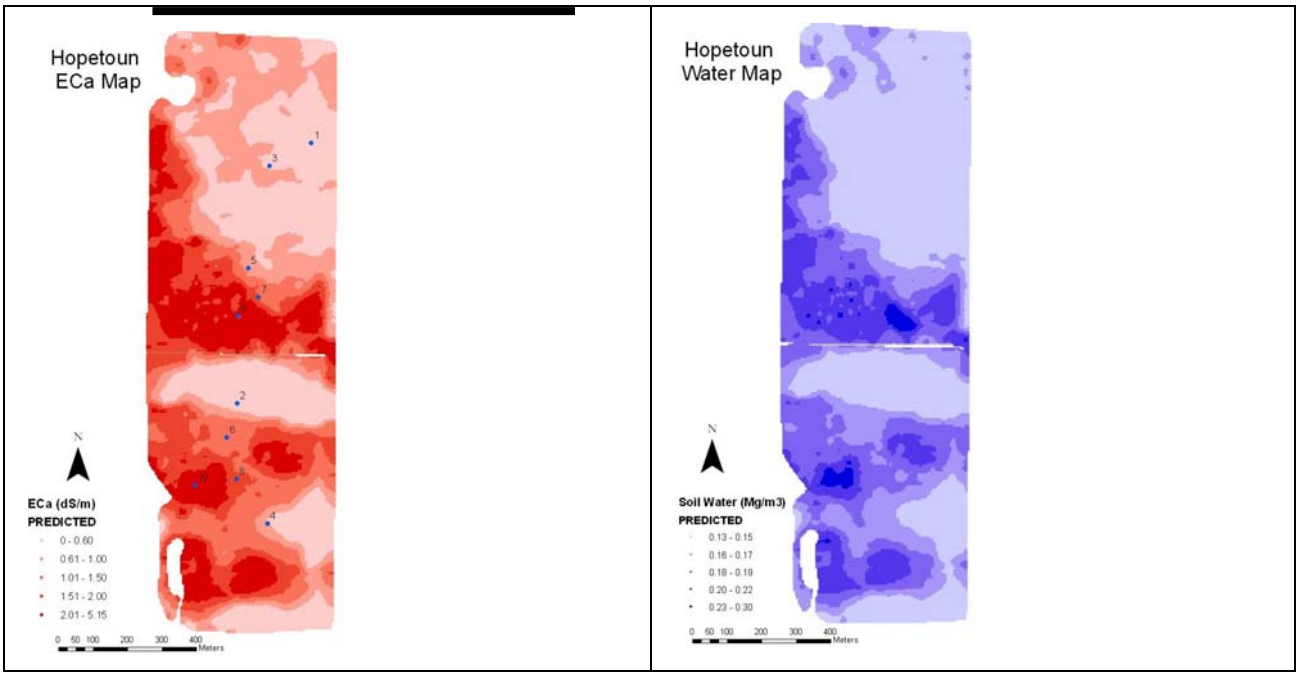



**Figure 2:** EM maps for ECa and soil water. (Dark = high EC/soil water, Light = low EC/soil water)

The ECa map (Figure 2) is drawn from the raw EM38 survey and shows the location of sample sites. The cropped paddock is in the north and lucerne in the southern paddock. The water map is calibrated from the soil water measured at these sites at five depths to 1.3 m.

From the chemical analysis taken at the ten sites the EM map can be calibrated to show Soil EC 1:5, Chloride and Boron levels across the paddock. These maps show large areas of the paddock where crop growth will be affected by high salt and boron levels. The lower slopes have high EC and Chloride values in the root zone, and this will also limit plant growth.

These areas have higher soil water and nitrate levels as plants have not been able to access the whole soil profile. A large amount of limestone on and beneath the surface in some areas, made soil sampling difficult.

Soil, Crop Monitoring and Yield Results for Hopetoun

The cropped paddock was sown on 14/6/05 to Sloop Vic Barley @ 60kg/ha with 90kg/ha Granulock 25-13 fertiliser. Lucerne was established in the pasture paddock in 2003

The higher EC in the soil profile of the lower slopes (Table 1) highlights the saline areas of the paddock and the reduced plant growth and subsequent yield. Barley yields ranged from 3.3 t/ha on the sand hill and slope to 1.7 t/ha in the saline affected, limestone lower slopes.

The lucerne was heavily grazed on the lower slopes and in the salt affected area lucerne plants were sparse to non-existent with large patches of bare ground. There is a wide range of plant populations across the paddock. The optimum number of plants for barley is 150 to 175 plants per meter square. Optimum Lucerne population is 15-25 plants/$m^2$.

Large populations of late germinating brome grass, ryegrass on the lower slopes created a lot of competition and will cause more management problems in the future.

**Table 1:** Sowing soil water, nitrate, EC, plant population, yield and protein results for Hopetoun.

| Site no | Description | EC dS/m 40-70 cm | Soil water total mm to 1m | Soil Nitogen Kg N/ha to 1m | Plants/ m2 avg | Yield t/ha | Protein % |
|---|---|---|---|---|---|---|---|
| | Barley Crop | | | | | | |
| H1 | Barley sand hill | 0.1 | 131 | 112 | 110 | 3.3 | 11.1 |
| H3 | Barley mid slope | 0.2 | 135 | 138 | 154 | 3.3 | 10.3 |
| H5 | Barley lower slope | 0.6 | 146 | 170 | 145 | 2.9 | 13.1 |
| H7 | Barley lower slope | 0.9 | 188 | 220 | 193 | 2.2 | 13.5 |
| H9 | Barley lower slope | rock | - | - | 138 | 1.7 | 13.1 |
| | Lucerne paddock | | | | | | |
| H2 | Luc/sand hill | 0.3 | 79 | 106 | 16 | Grazed heavily | |
| H4 | Luc/mid slope | 0.6 | rock | | 16 | Grazed heavily | |
| H6 | Luc/mid slope | 1.3 | 133 | 172 | 8 | + medic | |
| H8 | Luc/low slope | rock | rock | | 8 | + grasses | |
| H 10 | Luc/bottom slope saline area | 2.9 | 213 | 330 | 0 | Bare ground samphire, couch | |

**Waitchie Landcare Delivery site - EM maps, monitoring and yield results.**

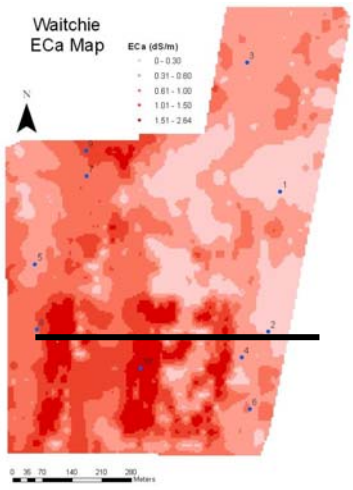
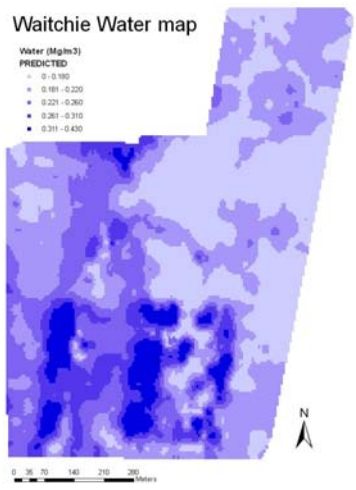
| EM map | Water Map |
|---|---|
|  |  |



**Figure 3:** EM maps for ECa and Soil Water. (Dark = high EC/soil water, Light = low EC/soil water)

The map clearly shows the cropping paddock (southern end) with higher soil water content in April than the Lucerne paddock (northern end). The maps show the large areas of the paddock where crop growth will be affected by high salt and boron levels (darker shading).

Soil, Crop Monitoring and Yield Results for Waitchie

The cropped paddock was sown on 26/6/05 to Sloop Barley @55 kg with 50 kg/ha, Granulock 10Z. Lucerne was sown in the pasture paddock in 2004.

**Table 2:** Sowing soil water, nitrate, EC, plant population, yield and protein results for Waitchie.

| Site no | Description | EC dS/m 40-70 cm | Soil water total mm to 1m | Soil nitrogen Kg N/ha to 1m | Plants/ $m^2$ avg | Yield t/ha | Protein % |
|---|---|---|---|---|---|---|---|
| | Barley Crop | | | | | | |
| W2 | bottom slope | 0.3 | 135 | 73 | 102 | 3.0 | 14.3 |
| W4 | bottom slope | 0.9 | 145 | 86 | 110 | 2.9 | 12.4 |
| W6 | bottom slope | 0.8 | 200 | 141 | 80 | 3.2 | 12.8 |
| W8 | sandhill | 3.4 | 292 | 294 | 112 | 2.3 | 14.2 |
| W10 | mid slope | 2.0 | 273 | 116 | 107 | 3.1 | 12.4 |
| | Lucerne | | | | | | |
| W1 | bottom slope | 0.3 | 103 | 198 | 25 | 30-40 cm high | |
| W3 | lower slope | 2.3 | 139 | 88 | 21 | 20 cm high | |
| W5 | sandhill | 3.9 | 217 | 224 | 15 | 20-30 cm high | |
| W7 | mid slope | 2.6 | 225 | 134 | 0 | medic+ barley grass | |
| W9 | mid slope | 4.5 | 289 | 188 | 1 | bare ground, barley grass, medic | |

The sand hill and upper slopes have high EC and Chloride values in the root zone which will limit plant growth. These are Copi (gypsum) hills caused by deposits of calcium sulphate (gypsum) and sodium chloride from the Timboram lake systems. Limited plant growth is reflected in the high soil water and nitrogen values in these areas from previous years. There were very few weeds in the cropping paddock but small areas of rhizoctonia were detected on the lower slopes at W2. Plant numbers are fairly even but low across the paddock with only about 100 plants per $m^2$. The optimum number of plants for Barley is 150-175 plants per meter square. Yields ranged from 3.2 t/ha on the lower slope to 2.3 t/ha on the sand hill with high EC levels.

Lucerne has grown very well on the lower slopes but establishment and persistence on the mid slopes have been severely effected by high EC levels and there are large patches of bare ground and few pasture or weed plants. The top of the sand hill has a reduced number of plants but is still persisting well.

Wind Erosion Risk

Wind erosion risk was measured post sowing at both Hopetoun and Waitchie in the cropped paddocks. All sites in the cropped paddock were rated low risk of erosion because of the stubble/plant cover and large aggregate size of the soil. The erosion risk will be measured again post harvest.

## Interpretation

The EM maps visually highlight areas in the paddock with different levels of Electrical Conductivity. Soil water and chemical analysis of these different EC levels can calibrate the maps to give good indications for different levels of soil water and subsoil constraints (EC, Boron, Chloride). Areas mapped showing high levels of soil water and subsoil constraints have had a detrimental affect on both pasture growth and persistence and crop growth and subsequent yield in the 2005 season.

## Commercial Practice

EM surveys can be a relatively cheap ($5/ha) and a useful tool for showing different soil types and subsoil constraints in your paddock, adding to the knowledge you have of your paddock and its soils.

Possibilities for managing the cropped paddock differently could include increasing the sowing and fertiliser rates for the more productive areas of the paddock and reducing inputs into the poorer areas.

Areas where lucerne is not persisting may be better sown to salt tolerant species and fenced and grazed separately from the lucerne paddock.

## References

Leys, J.F., Semple, W.S., Raupach, M.R., Findlater, P. and Hamilton, G.J. (2002). Measurement of size distributions of dry soil aggregates. In: “Soil physical measurements and interpretation for land evaluation”. Editors: McKenzie, Coughlan and Cresswell. CSIRO Publishing, 2002.

## Acknowledgements

Thanks to Pat Hallam at Hopetoun and Rob Hender at Waitchie, who have been fantastic collaborators on this project, hosting the sites and allowing the project team access to their properties.