

# Electromagnetic Soil Mapping – Implementing the Outcomes

Quenten Knight, Consulting Agronomist, Precision Agronomics Australia, Esperance WA

## INTRODUCTION

An increasing range of technologies that allow farmers to compile very detailed information about their paddocks is becoming available. It can be a challenge to organise this information so it makes sense and has some real use. Precision Agronomics Aust, supported by Precision Cropping Technologies are working closely with farmers to introduce these new technologies to aid management and agronomic decision making. The principal focus is to build a sound knowledge of the major factors influencing production and to generate practical outcomes that can be implemented by the farmer. Projects have commenced in the Esperance region and this is a brief discussion on some initial outcomes.

## METHODS

The first stages involve mapping and analysing the topography and soil variability. Electro Magnetic Induction technology coupled with an RTK GPS has been used to conduct an EM Survey. The DualEM is towed behind a vehicle and measures the apparent electrical conductivity (ECa) of the profile at two depths 0 to 0.5mt and 0 to 1.5mt. It senses changes in soil conditions by how well it conducts an electrical current. Various soil properties can influence the DualEM response including soil texture, electrolytes (salts) and moisture. The DualEM map is a guide to soil profile change but requires interpreting starting with soil-testing. PAA have established a service dedicated to this task and collect soil cores at targeted locations over the survey area. The soil-test results are then subject to detailed statistical analysis generating knowledge of where soil properties of agronomic importance are varying over the survey area. These can include soil texture, potential water holding capacity, CEC, Sodicity, boron, Aluminium and depth to clay etc.

## RESULTS

The 260 hectare paddock in the following example clearly demonstrates variability in soil type and topography that are having a big influence on final yield. The information gained from conducting an EM survey with RTK elevation data have provided us with the ability to identify the soil properties that were causing yield variation and some of the outcomes implemented to overcome this variation. Figure 1 below shows the relationship between EM and Yield where the canola yield is reduced at the low EM reading and also at the highest EM readings, whilst table 1 shows the implications to gross returns. The variations in yield and gross returns are best explained by the various graphs below where figure 2 represents the relationship between EM and clay %, strong correlations between constituents of soil particles or soil texture and EM were evident (clay  $r^2$  0.81, sand  $r^2$  -0.72). As the EM value increases, the soil profile 0-60cm has more clay and less sand with potential to hold more water (Figure 3) to support higher yields, providing that other sub soil constraints do not limit crop root growth.

Figure 4 shows that EM and cation exchange capacity (CEC) at 0-60cm were strongly correlated ( $r^2$  0.76), generally the CEC is a measure of a soils overall fertility and ability to hold onto applied nutrients.

Therefore the lower yields at the low EM values represented by zone 1 in Table 1 can largely be explained by the low clay % which results in the soils ability to hold less plant available water

exposing crops to periodic drought when rainfall events are infrequent. CEC is also poor resulting in poor nutrient availability especially after heavy leaching rains.

Figure 5 shows a positive relationship between EM and exchangeable sodium percentage (ESP) over 0-30cm ( $r^2$  0.83) and 0-60cm ( $r^2$  0.83). This data when used in conjunction with the strong correlation 0-60cm ( $r^2$  0.85) between EM and the Calcium/Magnesium ratio (Ca:Mg) in Figure 6, demonstrate that the trend to lower yields at the high EM values in Zones 4,5,6 and 7 are largely due to the sub soil constraints caused by high levels of sodicity and magnesium.

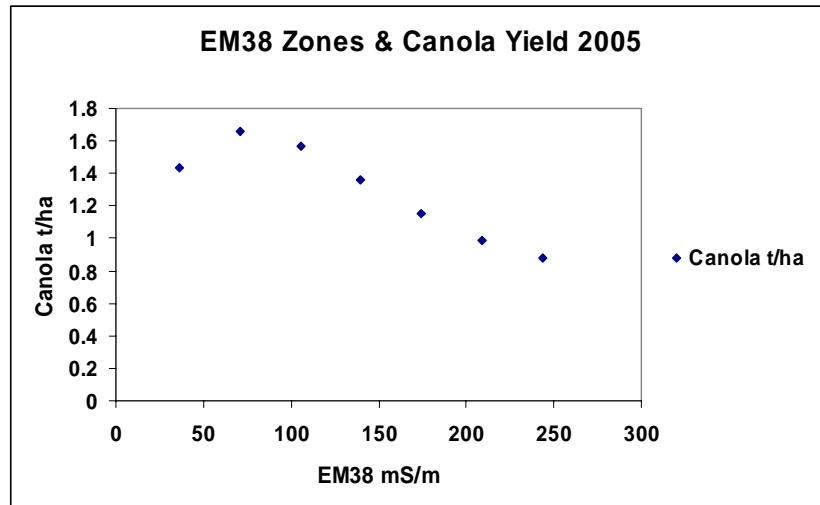


Figure 1

Table 1. EM Zones and canola gross returns

EM Zone	Ave EM Value	Ha	Ave t/ha	Gross \$ @ \$400/t	\$/ha @ \$400/t
1	36.6	37.1	1.44	\$21,341.33	\$574.97
2	71.0	64.7	1.66	\$42,850.13	\$662.38
3	105.5	114.3	1.57	\$71,698.38	\$627.04
4	140.0	33.2	1.36	\$18,048.21	\$543.08
5	174.4	9.3	1.15	\$4,285.44	\$460.15
6	208.9	1.4	0.98	\$539.37	\$393.93
7	243.3	0.4	0.88	\$137.97	\$350.90

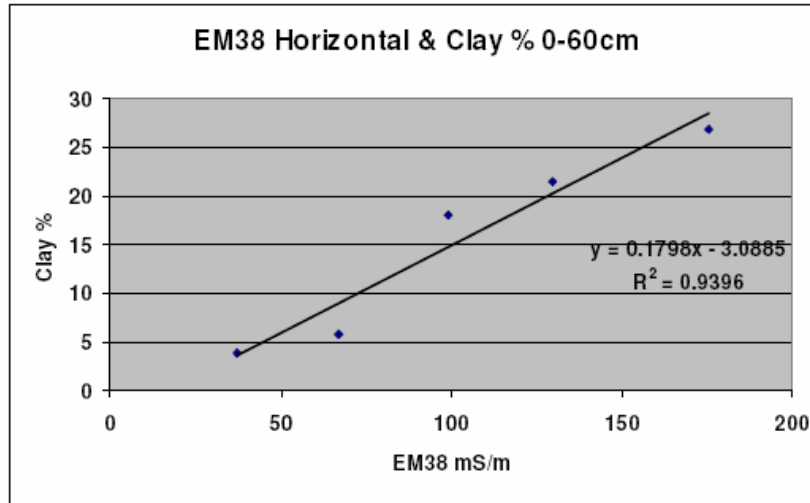


Figure 2

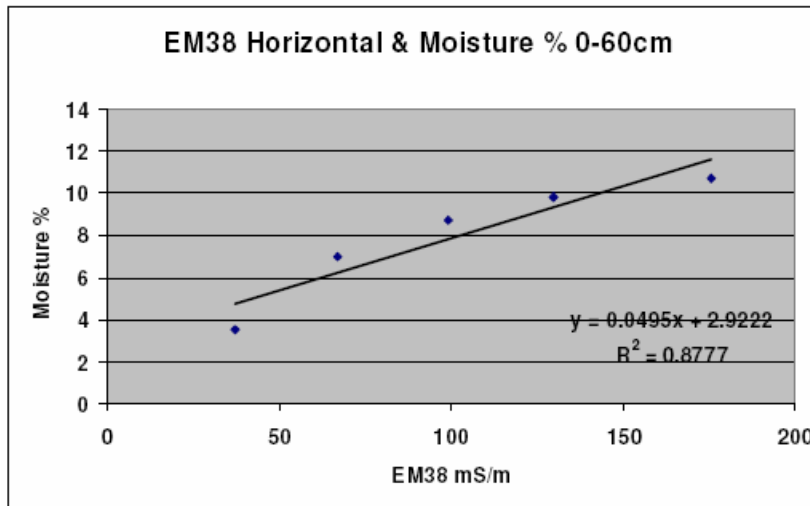


Figure 3

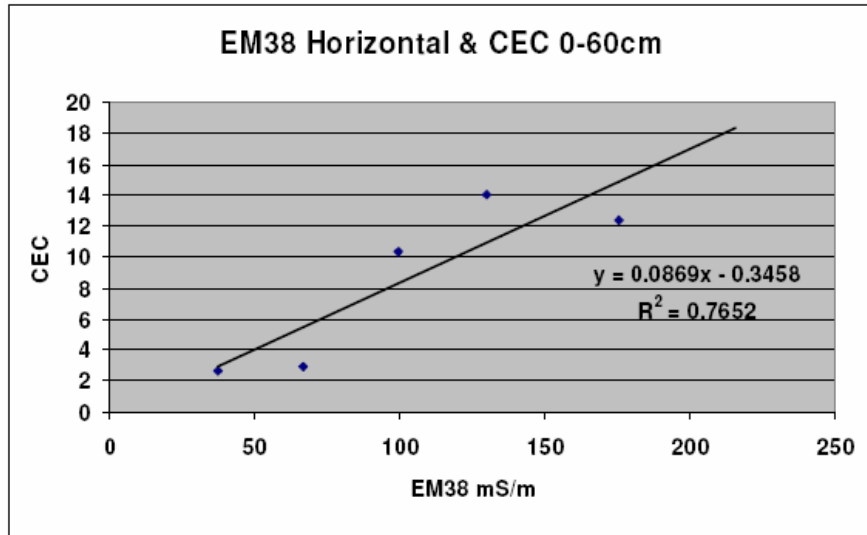


Figure 4

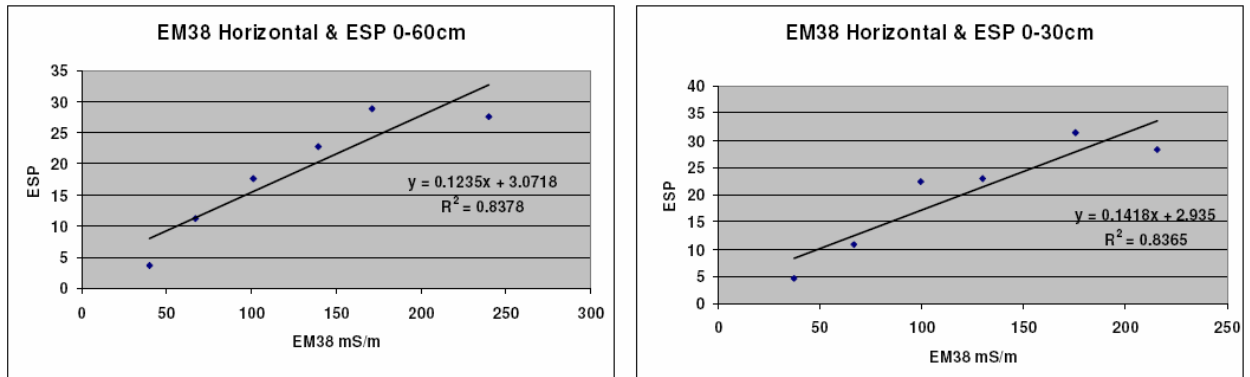


Figure 5

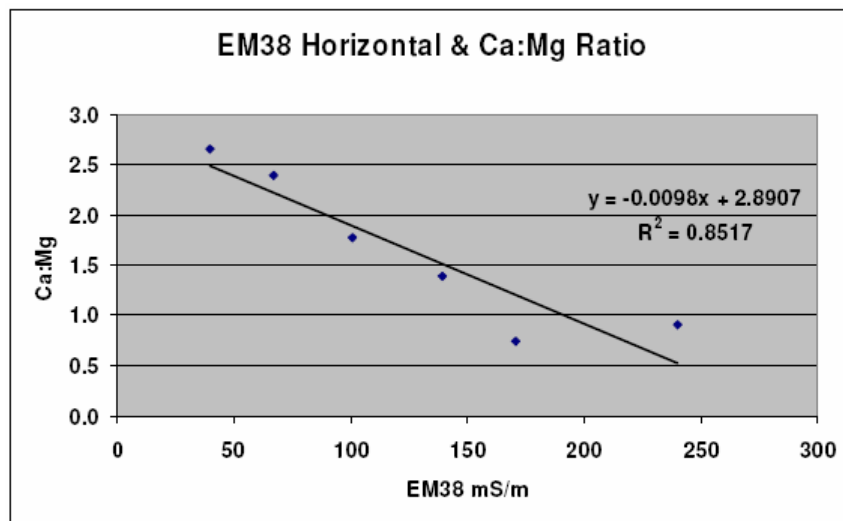


Figure 6

## DISCUSSION

It is now apparent that lower yields and gross returns are occurring in this paddock where EM values are low but also where they are high. We also now know through targeted soil testing and analysis what is causing these yield losses and are now in a position to implement some management changes aiming to improve yield and gross returns in these lower yielding areas.

Figure 7 shows a map of the 260 hectare paddock representing three different zones in which different management practices will be undertaken. Zone 1 represents 60 hectares of the paddock where low yields were occurring due to low clay %, Moisture %, CEC, average pH levels (0-10cm) of 4.5 and potassium levels (0-10cm) ranging between 25-47 ppm. The management strategy employed in Zone 1 include lime application at 1.5T/ha, Muriate of Potash at 50Kg/ha and split applications of Nitrogen and Sulfur to improve efficiency of these nutrients by avoiding excessive loss by leaching.

Zone 2 represents 133 hectares where standard management practices will be continued as the soil analysis has not revealed any chemical or physical constraints that are restricting yield.

Zone 3 represents 67 hectares, in this zone we know that the soil has the ability to hold more water and nutrients, however plants have difficulty in accessing this due to the sub soil constraints associated with high sodicity and magnesium. The management strategy to be employed in this zone is the application of Gypsum at 3.5 T/ha to improve water infiltration and avoid the previous periodic water logging and the subsequent hard setting of the soil within these areas. RTK elevation data from the paddock also revealed that areas in Zone 3 also require minor surface drainage to drain water from some low lying areas.

Zones 1 and 3 were spread individually with each fertiliser or soil ameliorant with a Marshall multi spreader using farmlap guidance.

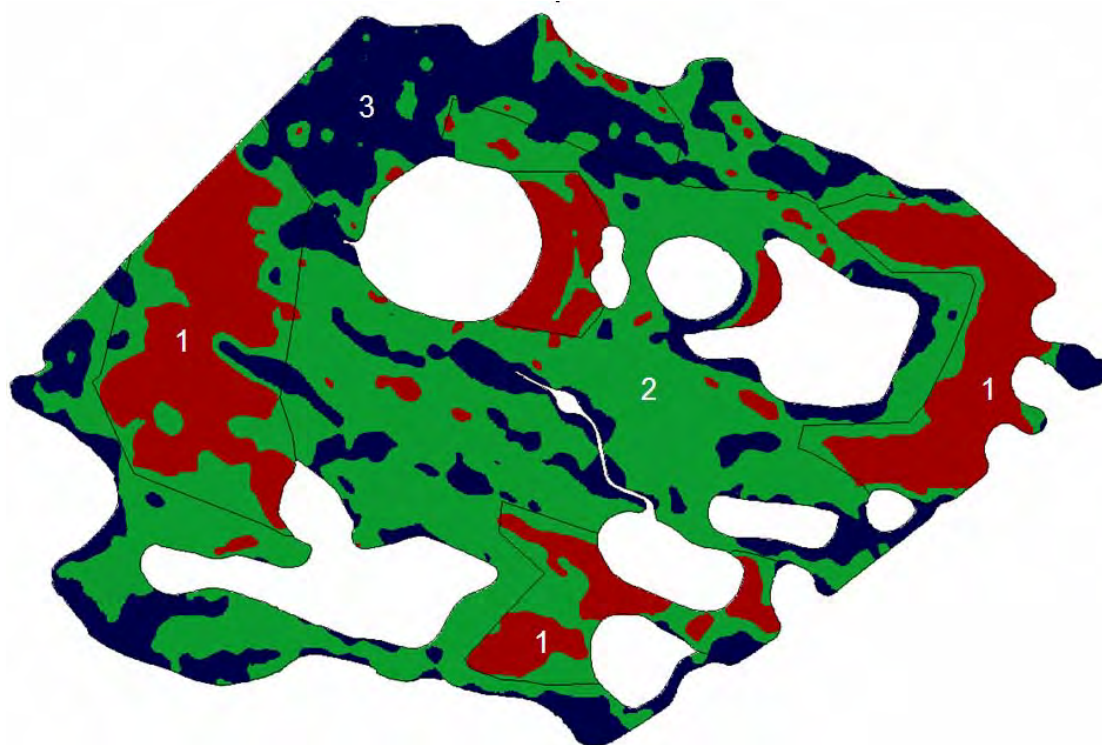


Figure 7

## **CONCLUSION**

EM soil mapping is providing us with a guide to soil profile change, this information when coupled with strategic soil sampling to depth is allowing farmers and advisors to make informed decisions on the management of soil properties both physical and chemical which are having either a positive or negative effect on yield.

EM coupled with GPS allows us to easily create separate management zones that can be treated individually from the remainder of the paddock allowing us to be more targeted with expensive farming inputs.

- PAA have found many agronomic benefits from EM mapping other than the example above, other outcomes that have been implemented include;
- Depth to clay maps for clay delving boundaries.
- Variable rate herbicide maps for soil types where ryegrass/weed numbers are consistently high.
- Variable rate gypsum and lime maps.
- Variable rate nitrogen maps for either Urea or boom applied UAN.
- Areas of future high salinity risk.

## **ACKNOWLEDGEMENTS**

Michael Wells – Precision Cropping Technologies SA.