Using precision soil mapping technologies to understand variability

R&D FARM-READY ADOPTION READINESS

Department of Agriculture and Fisheries

Alandale Produce, NSW

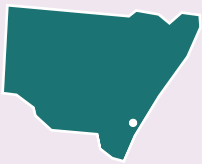
Jan 2020

Key outcomes

- EM38 survey and ground-truthing identified different soil types, areas of poor infiltration and areas of low soil pH.
- Management options included variable rate (VR) lime (rates of 250 kg/ha and 400 kg/ha) and variable rate gypsum (rates of 1.5 t/ha and 2.5 t/ha).

Background

Val and Sam Micallef produce a range of leafy vegetables and corn in Richmond, on the outskirts of Sydney. They had previously implemented strip tillage practices into their farming operations, as well as trialling soil moisture monitoring, with the aim to manage the variability in production across the farm. Their interest in other precision approaches was to gain further investigate and manage this variability.



Grower: Val and Sam Micallef

Location: Alandale Produce, Richmond, NSW

Area: 30 ha

What they grow: corn, lettuce, Chinese cabbage, cabbage, cauliflower, silverbeet and leeks

Soils: black cracking clay (Vertosol)

Topography: flat creek bank

Average annual rainfall: 660 mm (winter dominant)

Precision technologies implemented: EM38, zone sampling, GPS, drone-obtained elevation, drainage modelling, strip tillage, soil moisture monitoring

Activities

Mapping and ground-truthing

EM38 soil mapping across the farm occurred in three stages to accommodate the various crop rotations (Figure 1). The apparent soil electrical conductivity (ECa) ranged from 25 to 52 dS/m at 1.0 m depth, and was classified into three zones: Low, Medium and High (Figure 2). GPS referenced soil sampling sites were allocated across the three EM38 zones (Low, Med, High). The EM38 data was ground-truthed and validated through soil testing at each of these points (Figure 3). Soil samples were analysed for pH, electrical conductivity at 0.5 m and 1.0 m, soil texture, exchangeable cations and exchangeable sodium percentage at 0–15 cm and 15–30 cm.

Elevation

Waterlogging was evident in certain areas of the farm. Elevation data captured from the GPS during the EM38 surveys was analysed, but was found to be inaccurate due to the absence of an RTK base station.

A drone company from Sydney was commissioned to capture the elevation of the farm using a drone and ground control points to ensure accuracy to <2 cm on the ground.

"The technology we trialled have been beneficial in understanding variability across the farm. For the next steps, we are interested in looking at grid mapping new country to provide more detail for further variable rate practices." – Val Micallef

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Figure 1. EM38 sensor (top) being towed behind a tractor (lower) to measure soil texture at different points in the field. Source: Precision Pastures.

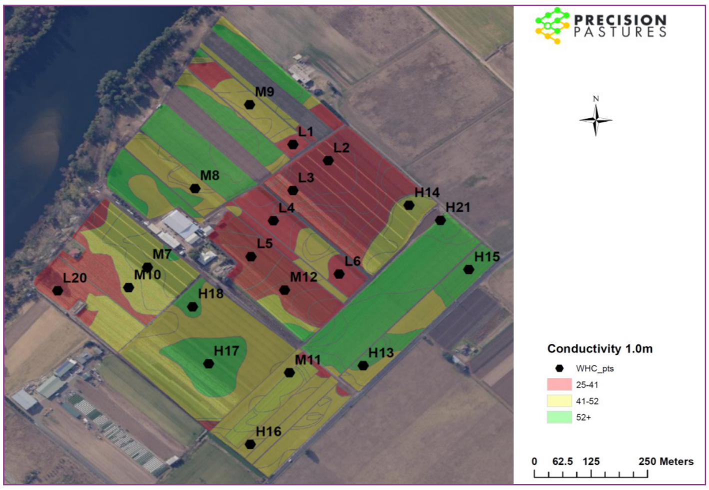

Figure 2. ECa map (at 1.0m depth) showing the variability in ECa across the farm (green areas are high ECa, red areas are low ECa). Black dots indicate GPS located points for soil sampling.

Figure 3. Soil sampling was conducted at each of the zones identified by the EM38 map. Source: Precision Pastures.

Results

Soil mapping and follow up soil testing indicated:

- Four soil types across the farm from Loam, Sandy loam, Loamy sand to Sand. This equates to 40 per cent variation in water holding capacity (WHC) based on characteristics of these different soil types. For example, the loam could potentially hold 2.5 times more water than the sand.
- Some areas of the farm with higher apparent EC than others reflected differences in the percentage of clay and Cation Exchange Capacity (CEC) (Table 1).
- Exchangeable Sodium Percentage (ESP) varied from 1.2 to 4.4 at 15–30 cm depth. Higher ESP and clay content sites coincide with areas of the farm where the top soil is prone to surface crusting, which can impede seedling germination and reduce water infiltration.
- In some areas of the farm the soil is slightly acidic, with a pH around 4 to 5, which can increase the potential incidence for club root disease (pH < 7) in brassicas as well as reduce the availability of some nutrients. The pH across Alandale varies from 4.9 to 6.9 at 15–30 cm depth.

Table 1. Representative sample points from a High, Medium and Low zones showing differences in pH, exchangeable sodium percentage (ESP) and EC (dS/m) from 0–30 cm.

Sample point	pH (1:5 $CaCl_2$)		ESP (%)		EC (dS/m)		CEC	
	1–15 cm	15–30 cm	1–15 cm	15–30 cm	1–15 cm	15–30 cm	1–15 cm	15–30 cm
High (15)	5.8	6.0	4.4	0.4	0.23	0.55	9.16	10.50
Medium (11)	6.2	6.6	3.6	2.8	0.11	0.12	8.33	7.92
Low (30)	5.8	4.9	2.2	3.0	0.11	0.09	5.6	3.47

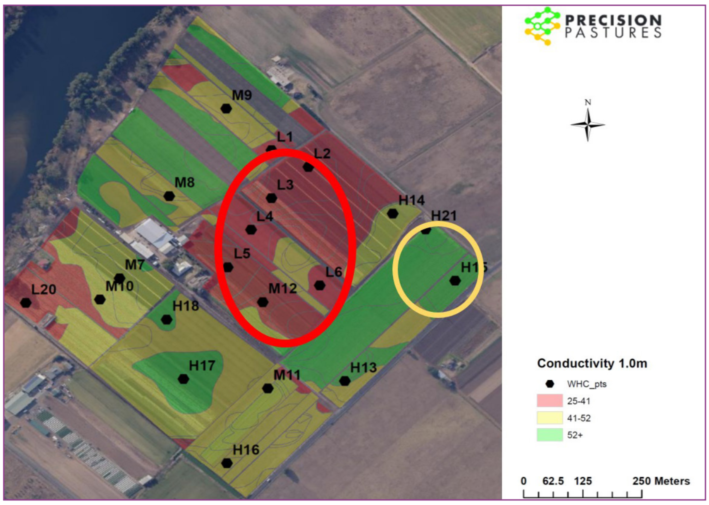

Figure 4. ECa map (at 1.0 m depth) Note: Red circle highlighting low pH areas for lime application and yellow circle highlighting area for gypsum application.

Management options

From the data generated through EM38 mapping and ground-truthing, Val and Sam have been able to implement a range of management practices to reduce variability across their farm (Figure 4).

- Lime was applied at variable rates of 250 kg/ha and 400 kg/ha, for 'high' and 'low' pH zones respectively, to manage variable pH and target an optimum pH of 7.
- Variable rate gypsum was applied to the whole farm (1.5 t/ha) and to ameliorate surface crusting and improve water infiltration in affected areas (2.5 t/ha). Standing plant residue from their strip tillage practices also contributes to improved infiltration in these areas. Gypsum application occurs when they undertake strip tillage operations to allow incorporation without adding another tillage operation.
- Val and Sam have commenced using soil monitoring equipment as part of the Soil Wealth project to more accurately match application rates to crop requirements. As part of this process, sprinkler nozzles have been varied to manage different irrigation requirements. The EM38 mapping has validated this work and identified opportunities to fine-tune this further and manage some of the constraints impacting on water use, i.e. infiltration issues.

Drainage modelling

Elevation data was obtained using a drone with RTK accuracy (<2 cm accuracy) to ensure the necessary level of accuracy for drainage modelling.

The elevation data was processed first to show the spatial elevation and waterlogged prone areas of the site. This allowed the analyst to determine the best scenario for a drainage model. Analysis has focussed the model on fields 6 and 7 (processed as two separate fields), with the option to create a whole-farm drainage model. As there is a dam at the southern end of these fields, the drainage model was created to lay out areas of cut and fill to encourage surface-water flow at a 0.2 per cent slope toward the dam.

There are also other areas of the farm that could benefit from subsurface, surface or cut and fill to improve drainage off fields. The options for drainage are still being reviewed and considered by the Micallef family.

Cost of technology

The cost of EM38 mapping: average $50/ha with travel costs additional.

Cost of ground-truthing sampling and analysis: $880 (inc. GST) (sampling) + $385 (inc. GST) (sample processing).

Elevation data captured by drone: $1815 (inc. GST).

Elevation data processing and drainage modelling: $120/hr. Total cost $330 (inc. GST).

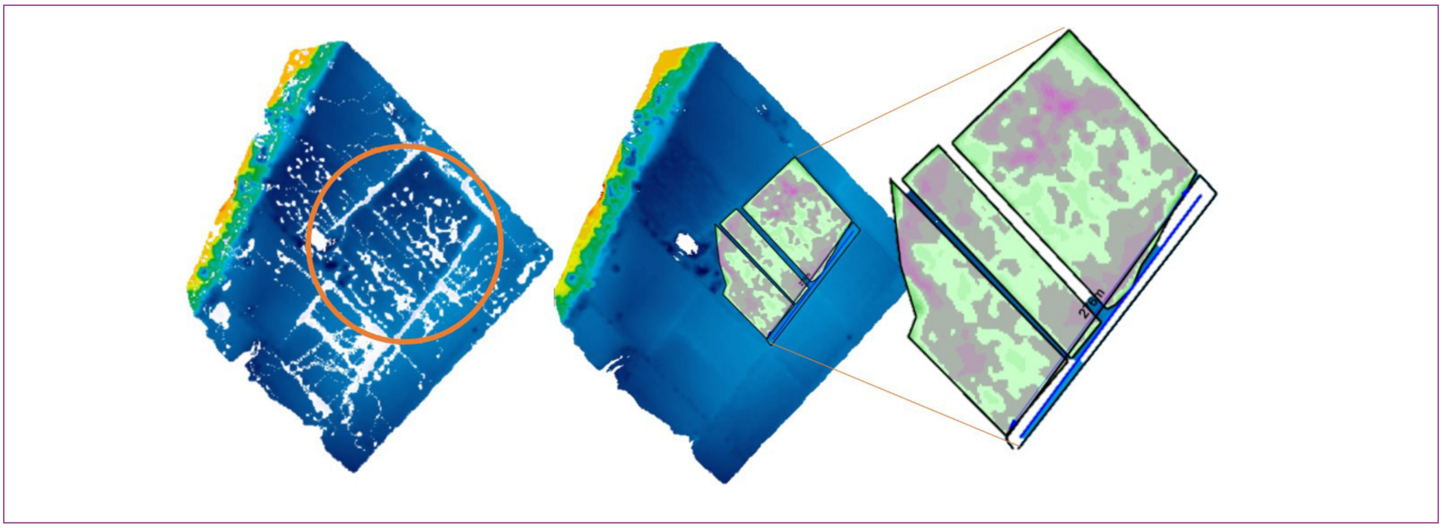

Figure 5. Left: Waterlogging map where areas in white are depressions in the topography where waterlogging can potentially occur on the farm. The area circled was chosen as an example for the grower. Middle and Right: the area modelled for surface drainage and movement of surface water off the field and towards the dam located on the farm.

Benefits

- Reduced risk/impacts of club root disease in brassicas.
- Reduced likelihood of waterlogging and soil crusting.
- Reduced crop variability from improved soil uniformity.

Challenges

Sourcing PA service providers within this region has been a challenge. The closest commercial PA service provider for EM38 mapping that could be found was five hours away, which significantly increased travel costs. A similar obstacle was encountered when sourcing VR spreading contractors, so manual VR application was the only option. Only the drone operator was located in the area, at less than two hours drove from the farm.

Where to next with PA

Val and Sam are interested in grid mapping to identify opportunities for variable rate applications of other inputs. Using this technology will allow Val and Sam to make more informed decision on how they optimise production on the area they farm. This could help fine-tune how they sample their blocks to create prescription maps.

PA service providers: Precision Pastures; XAG Australia; AgTech Services

Acknowledgements: DAF acknowledges the efforts and co-operation of Val and Sam Micallef from Alandale Produce, Greg Wynn of Precision Pastures, Charles Chow of XAG Australia and Michael Zwar of AgTech Services in undertaking this case study.

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Costs presented in this document were accurate as of October 2019. These will change over time and between data processing service providers.

Funding and Project Partners

une University of New England | Precision Agriculture Research Group | tia Tasmanian Institute of Agriculture | Government of South Australia Primary Industries and Regions SA | Harvest Moon | vegetablesWA | SPAA Society of Precision Agriculture Australia

Hort Innovation Strategic levy investment | VEGETABLE FUND

This project has been funded by Hort Innovation using the vegetable research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au