CASE STUDY 08 · AGRICULTURE

RemScan for Agriculture

Twelve soil parameters from a single 20-second scan — up to $100 of soil information per scan, in field and in real time.

BACKGROUND

Agriculturists are increasingly relying on data to guide land management practices. Further to this, global climate change is providing economic incentives for land owners to increase soil organic carbon stocks in soils to mitigate the amount of CO_2 in the atmosphere.

In response to these trends, GXLab is leveraging its expertise in hand-held Mid-Infrared (MIR) soil measurement to develop a suite of predictive models for analysing the properties of agricultural soils. Hand-held field measurement promises inexpensive, accurate, real-time measurement of a host of important agricultural parameters — empowering land owners and agronomists to confidently make important decisions in less time at lower cost.

Figure 1: Sample collection region across regional South Australia (approximately 1,000 samples).

In-field scanning at the 320-acre trial paddock, on a pre-established 100 m grid of 132 sample locations.

CALIBRATION MODELLING

GXLab conducted a proof-of-concept study to determine the viability of in-field MIR soil measurements. Regression models were generated from a dataset of approximately 1,000 soil samples collected from across regional South Australia. The samples were also measured at an accredited laboratory (APAL) for texture, pH ($CaCl_2$), soil organic carbon, phosphorus buffering index, cation exchange capacity, total inorganic carbon, calcium carbonate, and magnesium, potassium and calcium (AmmAc).

Laboratory and spectral data were processed in combination using multivariate and machine learning techniques to produce calibrations for each measured property. The data was split into training and validation subsets (70:30) based on spectral variance using the Kennard-Stone selection method, and calibrations were optimised by minimising prediction uncertainty on the validation set.

TABLE 1: CALIBRATION PERFORMANCE

PARAMETER	UNIT	MIN–MAX	RMSE	R^2
Sand	wt%	10–100	3.4	0.99
Silt	wt%	0–50	4.8	0.94
Clay	wt%	0–70	5.0	0.91
Soil organic carbon	wt%	0–3.5	0.22	0.91
pH ($CaCl_2$)	—	4–8.5	0.34	0.85
Phosphorus buffering index	—	0–300	20	0.95
Cation exchange capacity	cmol/kg	0–50	3.1	0.96
Total inorganic carbon	wt%	0–4	0.18	0.97
Calcium carbonate	wt%	0–36	1.5	0.97
Magnesium (AmmAc)	mg/kg	0–1,600	88	0.89
Potassium (AmmAc)	mg/kg	0–1,400	110	0.95
Calcium (AmmAc)	mg/kg	0–8,000	520	0.96

Five replicate measurements were obtained within 5 cm of each other at each sample point. Before measuring, loose plant matter and gravel were scraped away and the soil was tamped flat.

VALIDATION

A set of 40 validation samples was selected and sent to an accredited laboratory (APAL) for analysis. Figure 2 shows the correlation between in-field measurement by RemScan and laboratory assays. While there is more work to be done in improving predictive accuracy, the results are encouraging.

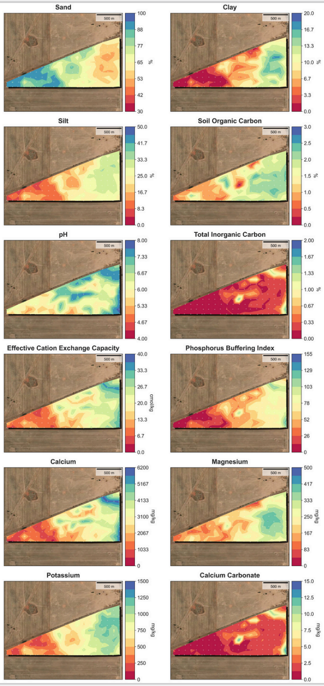

Figure 2: RemScan in-field measurement versus laboratory assay for each calibrated parameter.

CONCLUSION

In-field MIR measurements of soil properties can provide reliable data at a fraction of the cost of traditional laboratory measurement. Each 20-second scan provides all 12 calibrated parameters simultaneously — up to $100 of soil information per scan, obtained in field in real time. This work is ongoing, focused on increasing the size and variability of the training dataset and further demonstrating the utility of in-field scanning for precision agriculture and soil carbon mapping and monitoring.