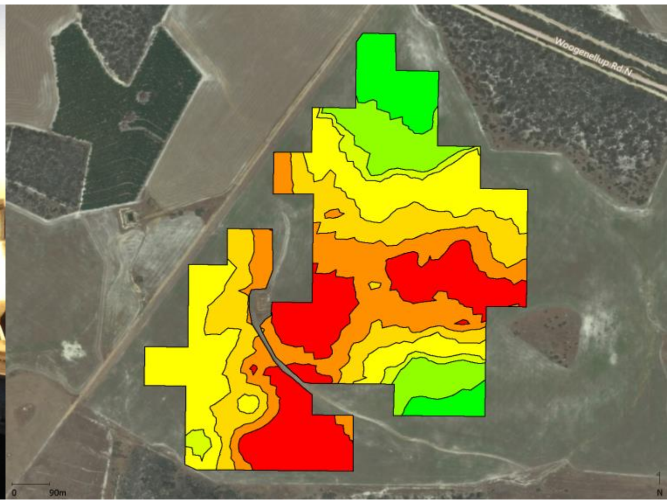
Economic and Scientific assessment of direct soil survey for the creation of high resolution maps of soil acidity and nutrition in the

Stirling's to Coast region

RGD14-C222d



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SOUTHCOAST NATURAL RESOURCE MANAGEMENT INC.

Australian Government

PRECISION SoilTech BUILDING BETTER SOILS

Acknowledgements

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A special mention needs to be made to John Blake (Stirlings to Coast Farmers) for his assistance throughout the project.

Contact details

Wes Lefroy
Precision Soil Tech
1800 644 951 – 0427 549 042
PO Box 212, Belmont, WA 6984

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Introduction

Soil acidity is a major constraint on productivity in the Stirlings to Coast Area. The report card on sustainable and natural resource use in agriculture (DAFWA, 2013) concluded acidity in the surface layer was extreme, with between 80 and 91% of samples collected being below the recommended 5.5 pHCa. Treatment of the soil acidification in this area may be difficult, as many lime sources in the area have a lower neutralising value and are of a coarser fraction than the lime sources north of Perth. This project not only seeks to slow acidity with remedial actions (more efficient liming strategies) but also with preventative actions (more efficient fertiliser usage).

The project examined the optimal level of direct survey (soil sampling) required to create topsoil and subsoil pH maps for variable rate liming, and nutrition maps for variable rate fertiliser application. The project determined change in confidence as sampling numbers are decreased across a number of soil types in the Stirlings to Coast region. An economic analysis will assess costs of applying more inputs than required and costs of increasing sampling numbers. The end result will be two graphs – confidence of soil variation vs number of sites sampled, and cost of soil sampling vs cost of excess application of nutrients. The conclusion will identify the most profitable density of soil sampling required to accurately represent pH and nutrition conditions in the soil profile.

Figure 1: Soil Sampling with Precision SoilTech's machine, west of the Stirling Ranges.

Summary of Achievements

The major activity of the project was to gain a true understanding of the variation of soil pH and nutrients across the Stirling's to Coast Farmers region for a more accurate application of fertiliser and limesand. To achieve this, 14 blocks of 50ha were soil sampled across the region at a resolution of 1 soil sampling site per ha. In total 700 soil sample sites were sampled (See figure 2 for locations of each block). At each sample site, soil was collected from the topsoil (0-10cm), midsoil (10-20cm) and the subsoil (20-30cm). Observations about soil type and gravel content were taken from each site for each depth. Samples from the topsoil were analysed for Colwell Phosphorus (P) and Potassium (K), Phosphorus Buffering Index (PBI) and pH (1:5 $CaCl_2$). Samples in the midsoil and subsoil were analysed for pH(1:5 $CaCl_2$) to gauge the extend and location of any subsoil acidity.

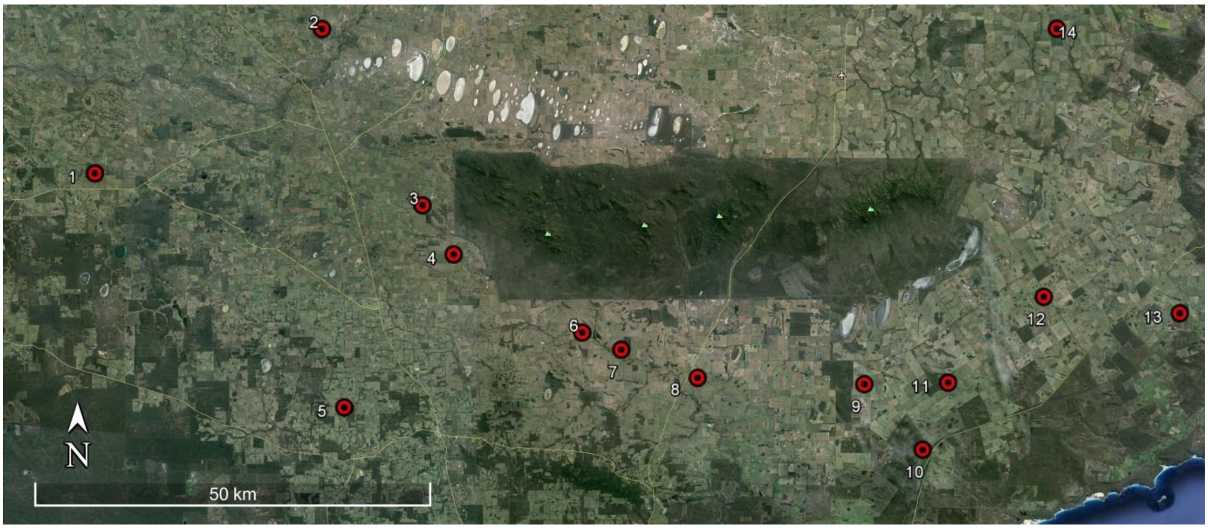

Figure 2: Distribution of the 14 soil sampling blocks across the South Stirling's Region of Western Australia.

Once the results were collated, high resolution maps were created for 12 different densities of soil sampling for each block. These maps formed the analysis of how the accuracy of the maps changed when the number of soil sampling sites was decreased. For each site, high resolution maps were made using 2, 4, 6, 8, 10, 15, 20, 25, 30, 35, 40 and 50 sampling sites respectively. Maps were created each for P, K, PBI and pH (topsoil, midsoil and subsoil) for each of the 12 densities. Each map was then correlated against the 50 sample map, which formed the scientific analysis component of this project. Figure 3 shows an example of how high resolution maps can change with the number of soil sampling sites.

In the initial calculations, sites were selected on spatial structure in order to attempt to cover the whole area rather than randomisation. As a follow up analysis, those paddocks with proximally sensed data (EM & Gamma) we re-analysed using the same process from part 1, but the sites were selected on EM and Gamma variation rather than spatial structure. Direct correlations between biomass data and yield data (where available) were also analysed for their relationship with chemical soil properties.

Figure 3: Two potassium maps of paddock 12. The left hand image was generated using 50 samples of K, compared to the map on the right, which was generated only using 6 samples of K.

The third part of the analysis was analysing the ability of each map to create an accurate prescription. For each of the 12 maps created, each of the sites was given a prescribed lime rate. Each of the maps was then compared against the highest resolution of sampling for accuracy. The analysis then worked out the over cost of any over applied, or under applied limesand, and compared this to the cost of soil sampling at each resolution.

The general trend from the economic analysis was that there are greater economic gains sampling at a higher resolution for lime application than phosphorus and potassium. This was due to a higher variation in lime demands across the sites than the nutrients.

Evaluation Questions

Impact

(Definition: A change in the condition of biophysical, social or economic and/or institutional assets. An impact may be positive or negative, primary or secondary, short term or long term, direct or indirect, and/or intended or unintended. Impacts are sometime realised after the formal project is completed.)

The desired impact of this project is that farmers to start thinking more spatially about soil variation and treating soil issues accordingly. For those 14 farmers that were involved in the project, they now have information to make more informed decisions about soil acidity management and efficient fertiliser usage. This project has also identified opportunities for those farmers to more effectively use soil sampling and soil mapping to understand the locations of any soil issues and methods about how to effectively place inputs.

Effectiveness

(Did the project deliver what was intended to be delivered? Did it meet, exceed or fall short of expectations? Definition: A measure of the extent to which a program, project or initiative has attained, or is expected to attain, its relevant objectives efficiently and in a sustainable way.)

All on the ground activities were completed in the expected timeframe. More sites were completed than planned due to support from Precision SoilTech and the amount of interest from farmers. The project met expectations in terms of deliverables within the project. With respect to the potential of the dataset, another full desktop project is required for the analysis to reach its potential.

Appropriateness (Methodology)

(To what extent were the project approach and strategies appropriate in influencing targeted stakeholders and achieving intended outcomes? Are there approaches and strategies that might be more appropriate?)

These methods addressed the goal of the project in a very logical manner. Soil mapping is a complicated subject – therefore it's imperative extension is delivered as simply as possible to increase uptake. The methods used in the project followed the soil sampling process that is used by farmers currently. The slight difference is that the testing was carried out at an increased resolution than what is currently undertaken. The strategy used was the most efficient method for answering the projects objectives.

Figure 4 Forest Gravel Soils evident at site 5.

Efficiency

(How efficient the project was in terms of cost vs. outcomes, time vs. outcomes, etc. Definition: The notion of getting the highest value out of program or project resources)

The program mapped a large amount of soil very intensively for the comparative costs. Where it is practical, data was obtained from the farmer in order to 'value add' the data that the project had paid for. A lot of time was spent refining the results analysis, which major source of inefficiency in the project, however this time was included as in-kind. The time spent on the ground was extremely efficient. All data communication was completed online which made the process far simpler.

Legacy

(Will the project's impacts continue over time and after the project ceases? How should the legacy be managed and by whom?)

The legacy of this project will be managed by Precision SoilTech and its staff. The goal of this project to raise awareness about best practice for soil mapping and identifying soil variation. We (Precision SoilTech) are more than happy to handle all associated questions on and interest. SoilTech has a strong emphasis on education, so carrying the legacy forward from this project will not be an issue.

Project Learnings

(Useful information for lessons learned and future projects can be identified by asking, what went well, what didn't go so well and what would we do differently next time, in the context of the project's scope, time, quality, cost, human resources, communications, risk, procurement, stakeholders and integration)

The amount of data that has been collected during this project has been enormous. Therefore to totally utilise all the data that has been captured, it will require one or more desktop projects to take this data to its full potential.

Taking this into account, it was important that this amount of data was collected for the Stirlings to Coast farmers to accurately understand soil variability. Extension is important and has been a focus for Precision SoilTech thus far.

Due to unforseen staff changes, we have been slow with the final reporting and interpretation. However this has not affected on the ground activities and extension of the project via field days.

Figure 5 - Loamy Clay duplex at Central Woogenellup. Left bucket is (0-10cm), centre bucket is (10-20cm) and right bucket is (20-30cm).

Future Recommendations

Farmers require a high quality of information to be able to supplement decision making in order to be as efficient as possible. This project has illustrated that low resolution soil sampling is not accurate for making high resolution applications of lime sand and fertiliser.

Farmers will benefit from a continued analysis of this data set. For instance, projects analysing trends within soil types, and particularly relationships with soil types and yield data. It is also important that advisors too are familiar with this data, as the farmers need to be continually receiving the same message. Continual extension of these results is important, and will be a focus of Precision SoilTech moving forward.

Figure 6 – Talking at the STCF Western Field walk about results from this project. Photo Tim Overheu.

Attachments

Technical Report
GIS Data Set