Performance through collaboration

PROJECT FACTSHEET

SOIL SENSOR TECHNOLOGIES – WHICH ONES ARE MOST USEFUL FOR SMARTER FARMING?

KEY POINTS

Opportunities exist to improve both *in-situ* and mobile soil sensors to measure physical, chemical and biological soil properties.

THE CHALLENGE

1. The purpose of the review was to guide investment by the Soil CRC in sensor research and development.
2. The review sought to identify approaches and opportunities by which soil properties can be sensed, spatially, temporally, and throughout soil profile depth.
3. There are many potential opportunities for investing in sensor development. The challenge is to identify those areas in which the Soil CRC can have greatest impact.

THE OPPORTUNITY

An opportunity exists for the Soil CRC to develop new, innovative, grower-focused sensors and tools for better measuring, understanding and managing agricultural soils.

OUR RESEARCH

A desktop review of soil sensing was conducted in three separate soil domains - (i) physical (ii) chemical and (iii) biological - whilst acknowledging the three domains are highly complementary. A workshop involving Soil CRC participants and a survey of industry end-users was conducted in collaboration with the Soil CRC Soil Indicator Review Project 2.1.01.

OUTCOMES

The following methods of sensing soil properties were reviewed:

- Non-optical methods – 11 sensor types identified and 38 sensors reviewed.
- Optical methods – eight sensor types identified, analysis of 16 types of soil properties reviewed.
- Electrochemical methods – three sensor types identified, two current systems identified.
- Biological sensors – 17 sensor types identified.

The project identified the following key attributes required for successful soil sensing and suggested possible future research directions:

1. Development of enabling technology required for future sensor application, including:
   - systems to improve on-farm and off-farm communication of sensed data
   - the ability to extract soil water for chemical analysis from both dry and moist soils
   - the ability to predict soil model parameters from existing moisture monitoring probes; and
   - the ability to integrate sensors with crop systems models.
2. Improvement in the usability of existing soil sensors and technology, including re-examining the use of integrated electromagnetic (EM) and electrical resistivity for measuring near surface soil properties, and the development of more usable soil moisture sensor - data integrated tools.
3. Continued development and evaluation of promising technology including multi sensor platforms such as Soil Condition Analyses System (SCANS) and evaluation of the range of emerging technologies for rapid analysis of soil chemistry.
4. Examination and testing of important and emerging soil biological health indicators with potential to aid in the development of biological health sensors for on-demand assessment and for use in field-based tool kits

Next Steps

1. Further review and understand the potential agricultural applications of emerging technologies for measuring and mapping soil moisture and soil compaction, including the use of microwave spectrometry, ground penetrating radar and seismoelectrical approaches.
2. Further review and investigate potential sensors for rapid and or mobile measurement of soil water holding capacity, soil water retention, and infiltration.
3. Further review and investigate emerging soil biological health indicators with potential to aid in the development of biological health sensors.
4. Improve our understanding of the use of soil sensing by Australian farmers - what is being sensed, how is it being sensed, why is it being sensed, what else should be sensed.

Project Team

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Project Reports/Publications

West D.J., Tarbath M., Grelet G., Lobsey C., Koela N., Weber E., Shelley B., Hardie M., Roberton SD., Bennet J.M. (2018) *Soil sensor technologies: Towards intelligent farming system frameworks*, Final Project Report, Soil CRC.

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The CRC for High Performance Soils (Soil CRC) is bringing together scientists, industry and farmers to find practical solutions for Australia's underperforming soils. The CRC aims to enable farmers to increase their productivity and profitability by providing them with knowledge and tools to improve the performance of their soils. The Soil CRC is the biggest collaborative soil research effort in Australia's history. The Australian Government and the CRC's 39 participants collectively contribute $164 million to the Soil CRC through both cash and in-kind contributions. The Soil CRC has funding until 2027.

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