12th International Conference on Precision Agriculture (Sacramento, California, USA)

Development of an On-the-Spot Analyzer (OSA) for Measuring Soil Chemical Properties

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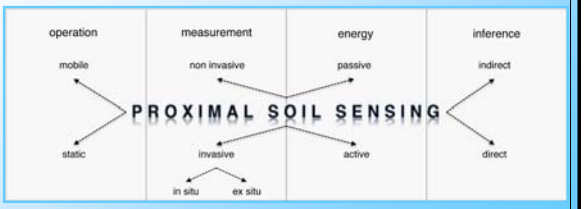
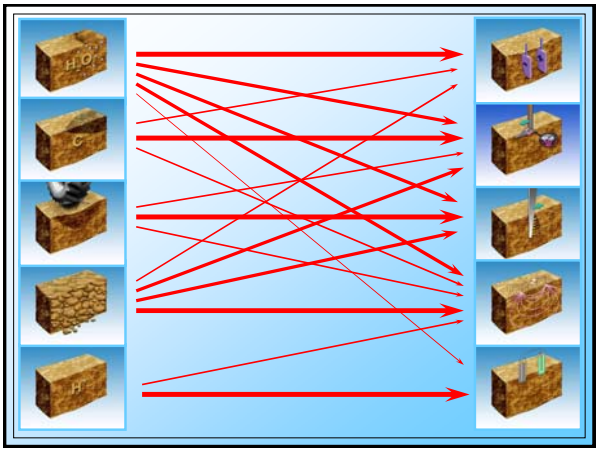
McGill

Proximal Soil Sensing

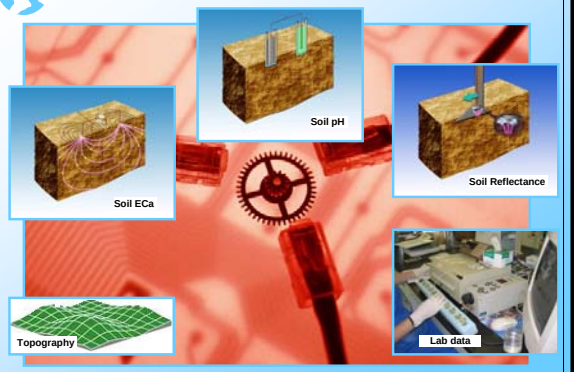
Proximal Soil Sensing (PSS) is a set of technologies developed to measure the physical, chemical and biological properties of soil when placing the sensor in contact with, or at a proximal distance (less than 2 m) to, the soil being characterized



Advances in Agronomy 113: 237-283

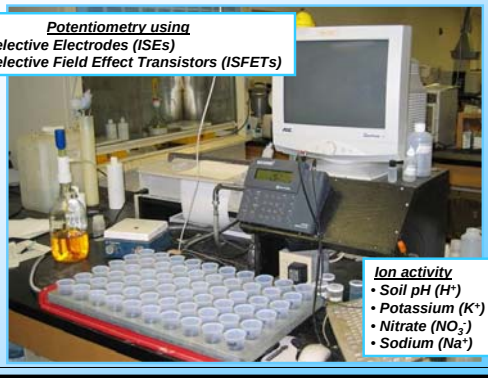


Sensor Fusion



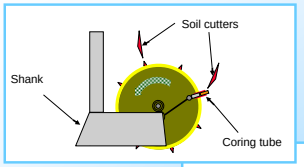
Electrochemical Sensors

Potentiometry using
- *Ion-Selective Electrodes (ISEs)*
- *Ion-Selective Field Effect Transistors (ISFETs)*

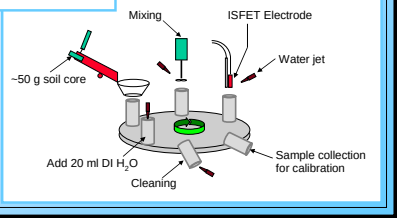


Ion activity
- *Soil pH (H^+)*
- *Potassium (K^+)*
- *Nitrate (NO_3^-)*
- *Sodium (Na^+)*

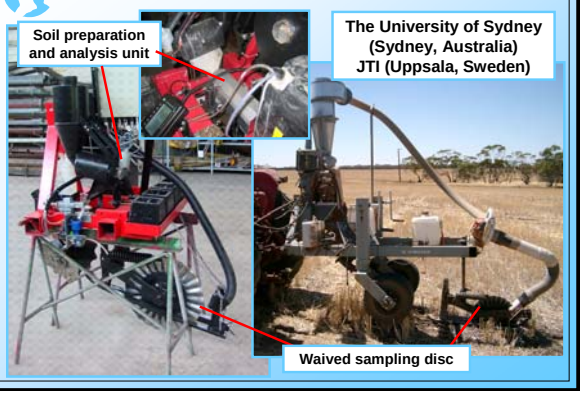
Automated Soil Testing



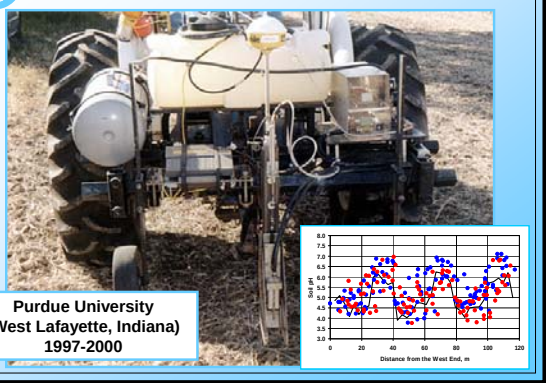
Purdue University (West Lafayette, Indiana) 1993-1996



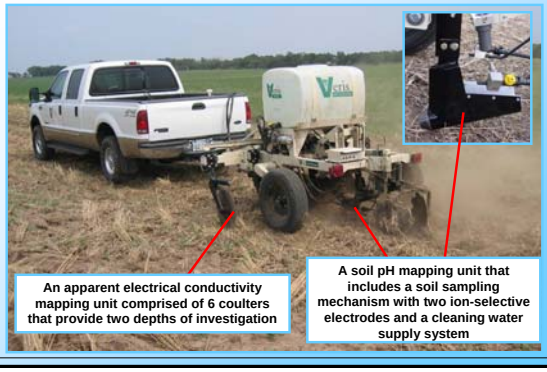
Soil/Buffer pH Mapping On-the-Go



Soil pH Mapping On-the-Go



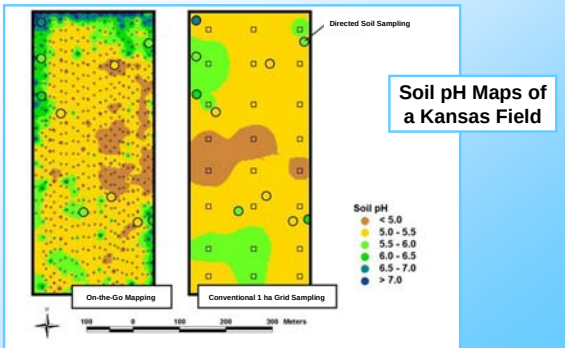
Veris® MSP



Veris® MSP3

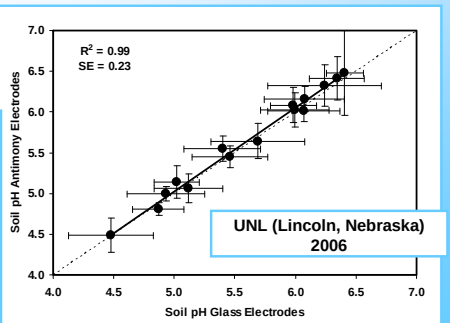
Example

Soil pH Mapping



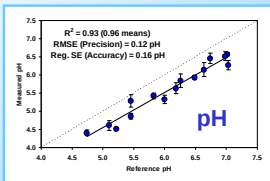
Antimony Electrode

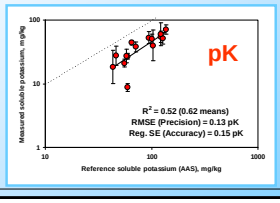
Sandy and stony soils

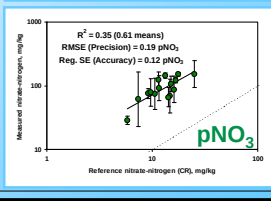


Integrated Direct Soil Measurement

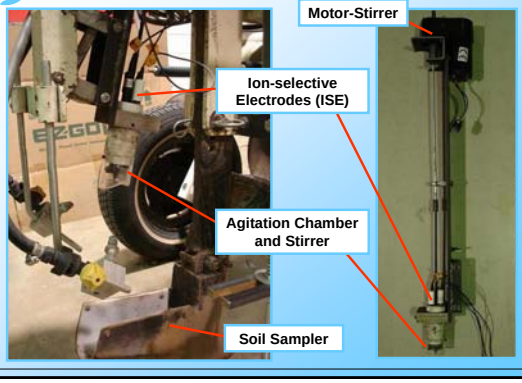
UNL
(Lincoln, Nebraska)







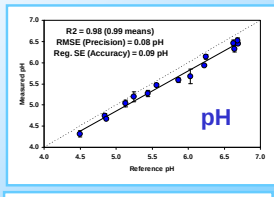
Integrated Agitated Soil Measurement

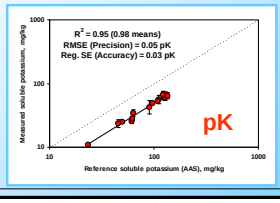


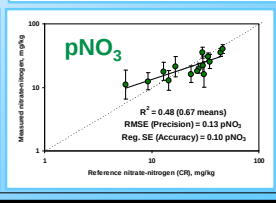
ASM - Laboratory Test

Reference tests:

- **Soil pH**
  - glass ion-selective electrode
  - RMSE = 0.05 pH
- **Soluble potassium**
  - atomic adsorption spectroscopy (AAS)
  - RMSE = 0.01 pK
- **Residual nitrate**
  - cadmium reduction (CR)
  - RMSE = 0.02 pNO_3

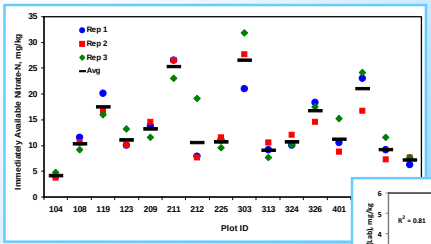


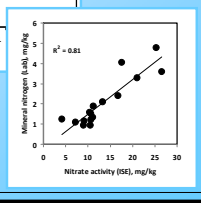




Portable Probe

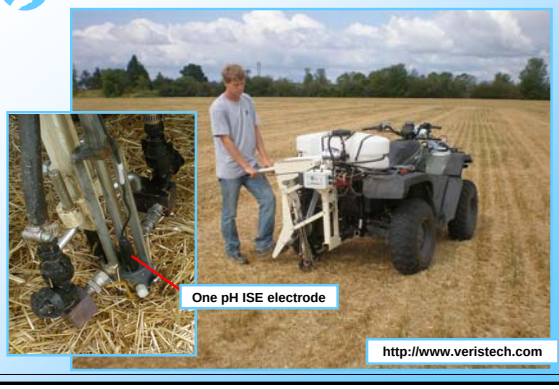
On-the-Spot Nitrate Sensing





Macdonald Farm (McGill)
2011

Veris® pH Detector



Semi-Automatic Soil Sampling

Point Measurements

Temporal monitoring

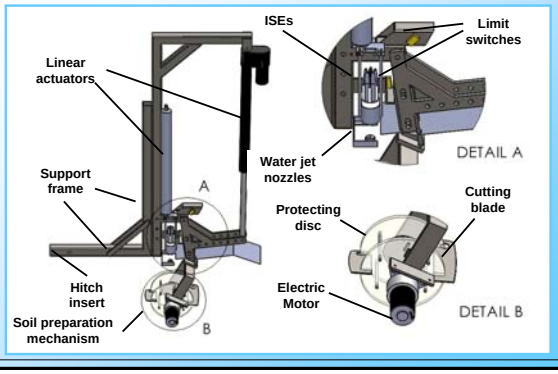
Soil profiling

On-the-Spot Soil Analysis

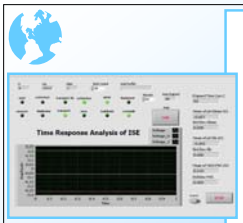
- ***In situ*** **measurement**
- **Predefined depth near soil surface**
- **Preconditioned surface**
- **Sensor integration**
- **Autonomous operation**
- **Vehicle versatility**
- **Low cost**

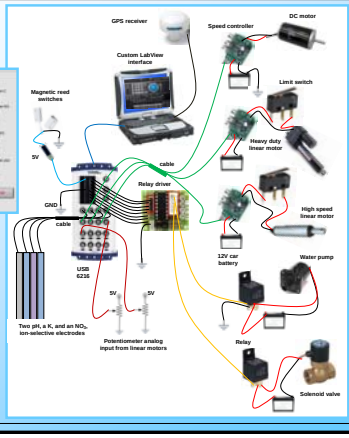
http://static.guim.co.uk/sys-images/Guardian/Pix/audio/video/2012/10/14/1350228832501/Mars-Curiosity-rover-test-012.jpg

On-the-Spot Analyzer (OSA)

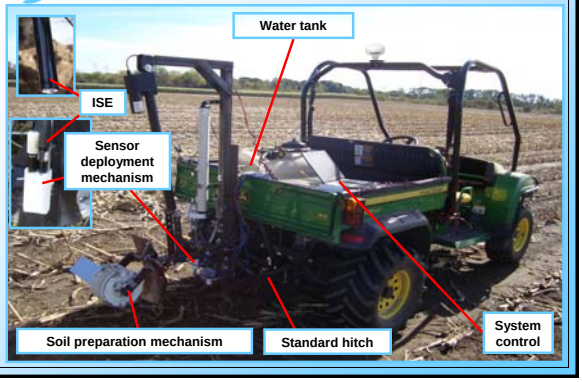


OSA Control

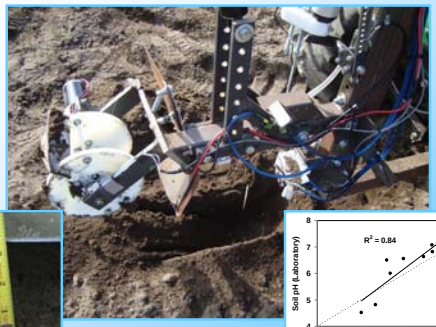


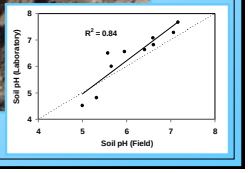


OSA Prototype



Preliminary Field Testing

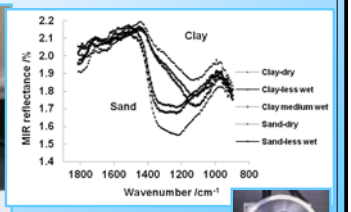




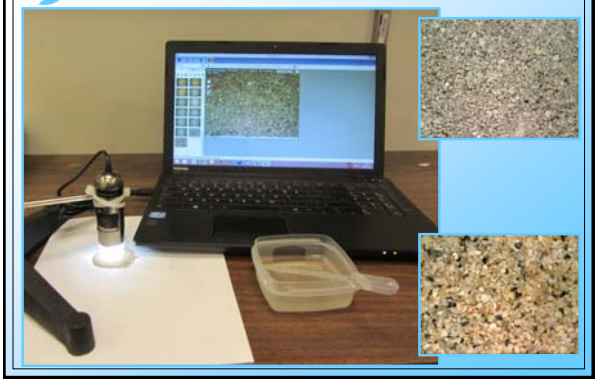
OSA Field Operation

MIR Spectroscopy

Diffuse Reflectance Variable Filter Array Mid-Infrared (MIR) spectroscopy - 2780-5096 nm or 5500-10800 nm



In situ Microscopy



OSA Highlights

The system was designed in such a way that it can be operated from the standard hitch of a pickup, an all-terrain vehicle, or another platform.

Measurement locations and density can be either predefined or adjusted in real time to respond to the quality and variability of the measurements already obtained at a given site.

The low destruction approach makes this method applicable to specialty and perennial crop environments.

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