Invited talk

An incomplete history of proximal soil sensing

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Summary

Proximal soil sensing, where soil properties are quantified by instruments operating very near or in contact with the soil, has recently received much attention. This workshop and the preceding one in 2008 highlight current interest in these sensing technologies that allow rapid and efficient measurement of spatial and temporal variations in soil properties. However, the old saying, "there's nothing new under the sun" could be said to apply here, as the history of proximal soil sensing is longer and richer than most would imagine.

Perhaps the earliest proximal soil sensor was a mechanical dynamometer capable of recording variations in tillage draft that was developed in the 1920s in England. This device was used to map contours of soil mechanical resistance in a 2.4 ha field. Considerable variation was reported in what was thought to be a uniform area – a story repeated many times across the decades as various researchers investigated soil spatial variation. Various incarnations of draft sensors have been developed over the intervening decades, with improved resolution, accuracy, reliability, and ease of use thanks to the progression from analog electronics to digital electronics, to computer-integrated measurement systems. Other soil mechanical resistance sensors (e.g., vertically and horizontally operating penetrometers) have also appeared and matured, but the general principles of the dynamometer from almost a century ago are still central to today's devices.

Sensing of electrical conductivity and resistance in soils also has a long history. As early as the 1940s, resistance block-based soil moisture sensors were developed and deployed in fields, and their use as a means of irrigation scheduling was being advocated. Similar moisture-sensing technology is still in use today. The 1970s found both geophysical soil resistance measurements and electromagnetic induction-based soil apparent conductivity (EC_a) sensing being used to locate areas of salinity. Today, EC_a sensors based on these two approaches are used to investigate various soil properties and EC_a is arguably the most widely applied type of proximal soil sensing.

A third proximal soil sensing methodology that has been used for decades is optical diffuse reflectance sensing. As early as the 1960s, coinciding with the rise of satellite remote sensing, many reports linked soil reflectance to various soil properties. Proximal sensing of reflectance characteristics began in the 1970s with efforts to estimate soil organic matter as an input to on-the-go variable-rate herbicide application. By the 1990s, advances in optics, electronics, and data processing methods reinvigorated research in reflectance sensing, which is now widely applied in research and is beginning to be used in practice.

Along with these three highlighted above, there are many other proximal soil sensing technologies with long histories. In many cases, a sensing approach has been revisited several times over the years. Although the basic principles behind the sensing approaches may be unchanged, improvements in electronics and computer systems have often led to better accuracy, reliability, and ease of use. This coupled with an increased willingness on the part of farmers and other users to embrace information-based agriculture has led to the current keen interest in proximal soil sensing and to this Second Global Workshop on Proximal Soil Sensing.