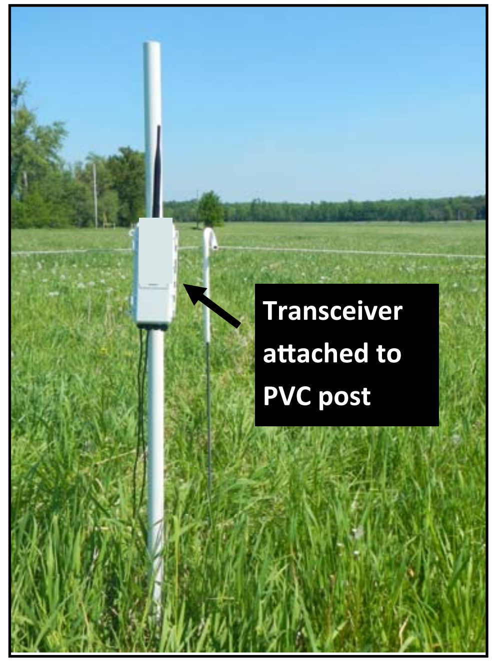
CENTER FOR SUSTAINABLE AGRICULTURE

UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

Field Testing Soil Moisture Sensors for Improved Pasture Management



Soil health is critical for maximizing economic and environmental benefits in agriculture; preventing compaction is a key aspect of its management. Compacted soils hold less air and water, are less able to support diverse soil organisms, limit plant root depth and result in less infiltration and more runoff. All of these can lead to reduced forage yield and quality, and may negatively impact water quality.

In a grazing system, soil compaction happens when livestock are released onto pasture that is too wet, or by heavy equipment. Soil type and landscape position influence how soils respond to moisture. Managing this can be challenging, especially in cool, humid climates like the Northeast, which is getting wetter with climate change. Over the last century, average annual precipitation has increased by over four inches, with localized increases even higher.

What if a farmer had real-time information about soil moisture conditions? Would a farmer have safe places to graze after rain events; could that help minimize compaction and maximize pasture production?

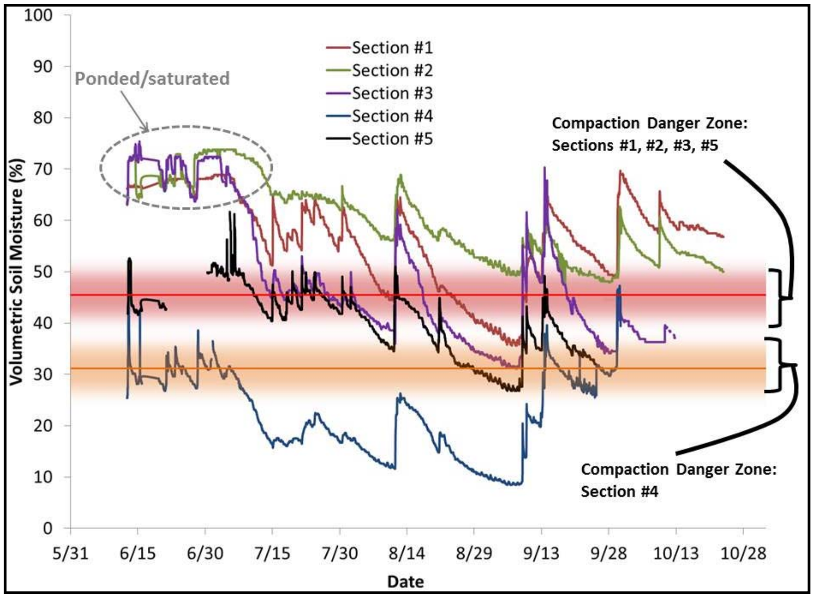
Methods: We developed a proof-of-concept study using soil moisture sensors to identify when a field section was within a compaction danger zone. The collaborating farm is a 60-head grass-based beef operation that uses management intensive grazing techniques. The demonstration field soil was primarily Covington, a heavy clay soil typical of the Champlain Valley, which stays wet longer, is more easily compacted, and can crack and swell.

Setting Up the Sensors: Utilizing sensors designed for irrigation scheduling, we installed transceivers and sensors along a fence row within the study field. Up to four sensors can connect to each transceiver. Transceivers send real-time data to a receiver installed in a nearby barn with an internet connection. An online application allows the user to view, graph and export data from a mobile device or computer. Within an 80-acre pasture, we installed sensors in field sections in late May and removed them in the fall, in 2015 and 2016. Field sections were defined by similar landscape position (e.g., upslope or downslope) and soil type. Each section was further divided by the farmer into paddocks during grazing rotations. The first year we installed sensors in five field sections, the second year in four sections.

Measuring Compaction: Compaction danger zones were determined by calculating the moisture content at which compaction potential is maximized. This "plastic limit" is determined by subtracting the plasticity index from that soil layer's liquid limit, using Soil Survey data.

Sensor being placed in the ground

Results/Discussion: Transmitters maintained communication more consistently in the first year than in the second, highlighting the importance of sensor duplication, reliable hardware, and technical support from manufacturers: we will focus our discussion on 2015 results. We graphed soil moisture through time, and overlaid estimated compaction danger zones for each soil type (below). The danger zones correspond to the plastic limit of the soil, +/- 5% soil moisture.



Paddocks in Section 4 contained a lighter soil, and were generally drier than the other sections. During record precipitation in June 2015, soil moisture was over 60% in several sections, and ponding occurred in lower fields. Soil damage is of more concern than compaction at these higher moisture contents. Section 2 had high soil moisture throughout the season, whereas other sections moved out of the compaction danger zone as they dried. **There was almost always a field section that was at a safe moisture content, allowing for rotation.** Soil type was important but not a consistent controlling factor.

Farmer Feedback: Up to this trial, the farmer relied on knowledge of soil types and visual cues to determine soil moisture. He found the real-time data useful for knowing when the soils were in danger of being compacted, and used the graphing feature to compare year to year and relate to his grazing plan. He was able to calibrate his field observations with the measured data in real-time, so that he could more accurately determine using sight and touch when a soil was at risk of being compacted. He found it to be a useful concept that needs more exploration and improved sensor reliability.

"Sensing and data are the future for proper management of soil for soil growth, and quantifying that process as an ecosystem service. Many more data points are needed to manage the process optimally. This is just the beginning."

Conclusions/Applications: There is an identified need to minimize soil compaction: this project provides a proof-of-concept for management based on real-time soil moisture monitoring. We confirmed that soil type is important, but other landscape and seasonal effects play a significant role in soil moisture. The sensors provided information not seen with eyes and maps alone, and reduced the labor of paddock investigation. Improvements and next steps include: developing reliable sensors for forage systems, demonstrating the cost/benefits related to farm size, and protecting the sensors from field operations in annual production systems.

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