

# LOW-COST SOIL MOISTURE CALIBRATION FORT COLLINS

Mia Morones  
Eli Brudie

Ansley Brown – Assistant Director  
Dr. Joel Schneekloth – Water Resources Specialist  
Adrian Card – Agricultural/Natural Resources

## ABOUT THE PROJECT

Irrigation and efficient water use prove to be essential factors in the world of Agriculture. The science behind measuring and tracking water use is valuable and has room for expansion in modern crop/farm practices. The focus of this internship was calibrating commercial soil moisture sensors using established methods of calculating volumetric water content along with using research techniques to calibrate experimental low-cost soil moisture sensors originally developed by Dr. Jay Ham in the department of Soil and Crop Sciences.



Research for this project was carried out at the Irrigation Innovation Consortium (IIC) Headquarters under the supervision of A.J. Brown. The IIC mission is to “support research to develop and accelerate the adoption of water and energy efficient technology practices”. This internship focused on developing low-cost soil moisture sensors with the intent that they will one day be available at an affordable cost for large and small-scale farms, golf courses, business with plots of land, and even individuals looking to better track water usage in their gardens. The development of a low-cost sensor and an online interface that easily monitors soil moisture for irrigation scheduling is a valuable tool for responsible water use.

## INTERNSHIP GOALS

- Obtain rudimentary farm management skills
- Gain experience in research project design and implementation
- Grow an understanding in research and business relationship development for consortium projects

## RELEVANCE TO MY EDUCATION

This internship provided me with experience that I can directly put into use in my study of Environmental and Natural Resource Economics. Agricultural science and management both play a substantial role in this field of work in the terms of:

- Behind the scenes business development
- Experience in collecting data and analyzing data for the benefits of a natural resource
- Cost-Benefit analysis
- Irrigation management skills

## SENSOR CORRECTION & CALIBRATION

### Sensor Installation

We installed and updated programs for 12 commercial sensors between our two fields in four separate locations at the depths of 15 cm, 50 cm, and 80 cm. The sensors were attached to data loggers where they logged hourly data of volumetric water content (VWC), electrical conductivity, permittivity, and period average.



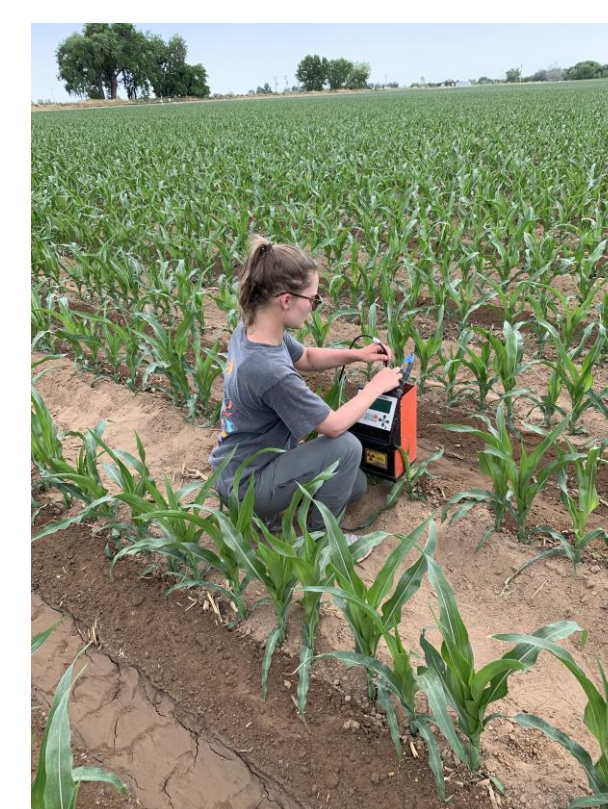
Commercial and DIY sensor stuck into soil profile



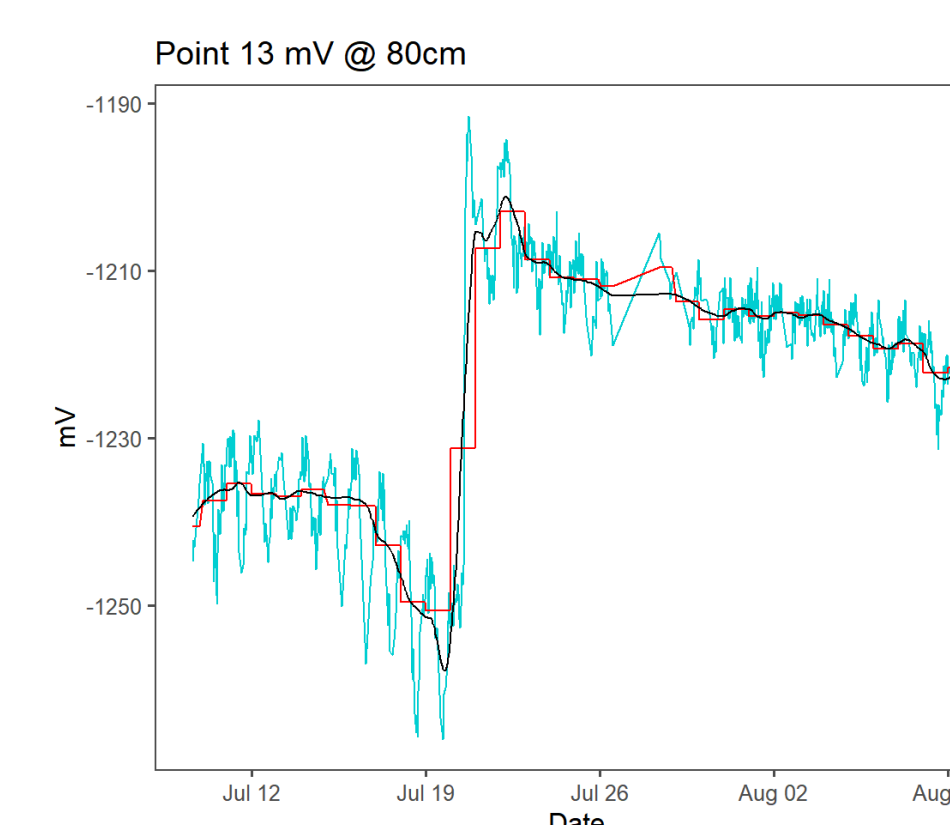
Up close photo of DIY sensor

### DIY Field Sensor Calibration Technique

A few times a week we used a neutron density gauge at four sites to take neutron counts that could then be converted into accurate measurements of VWC to be compared with measured sensor readings from the commercial and DIY sensors.



Mia recording neutron counts with the neutron probe



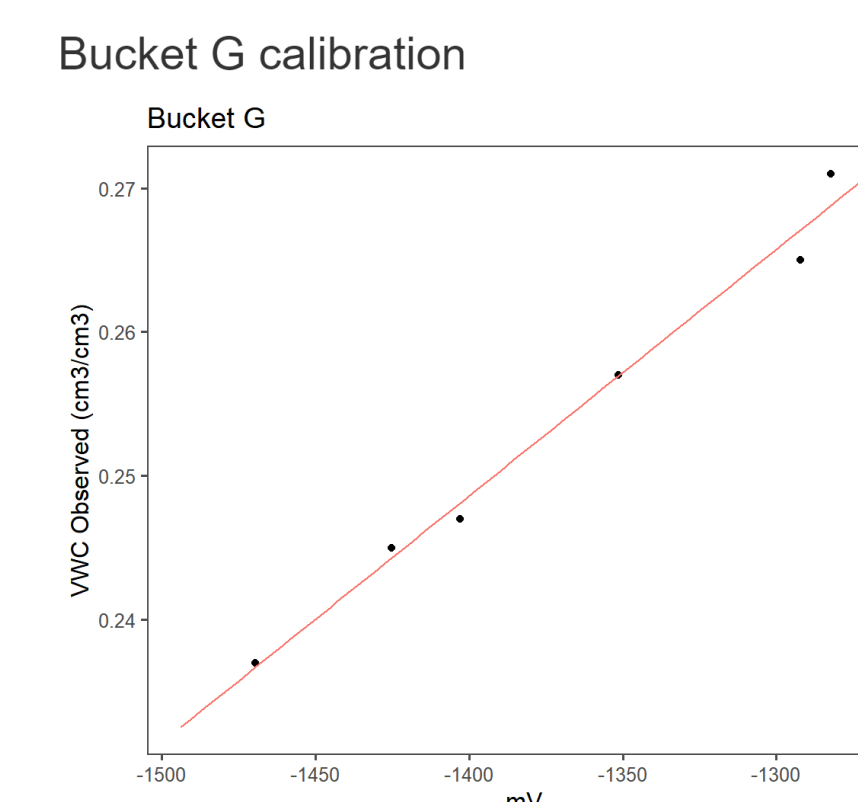
Graph showing mv readings with the DIY sensor

### DIY Controlled Calibration Technique

Our controlled experiment consisted of 12, five-gallon buckets that were weighed daily to track evaporative loss. Weights were converted into VWC and compared to both commercial and DIY sensor readings to identify correlations



Bucket experiment set-up with attached solar panel

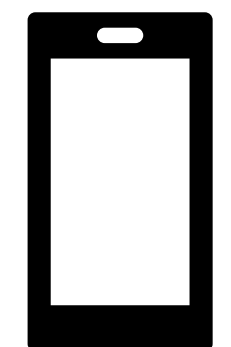


This graph shows the calibration of one of the DIY sensors to a commercial sensor in bucket G

## ONLINE INTERFACE

To be able to easily access the data collected from the sensors, an online database called Ubidots is used. The benefits of using Ubidots as the database for the sensors are:

- Real time data collection
- Easy to understand data visuals
- Mobile phone access



Scan to be taken directly to the Ubidot sensor dashboard!



Scan to be taken to graphs of sensor correction and calibration

## FARM MANAGEMENT



Ditch Burning to clear out the path for water flow



Aerial view of weekly flood irrigation



Weekly corn growth monitoring was used to check phenological stage and height of corn



The headgate was used to control flow of water to the irrigation ditches

## NEXT STEPS

To continue the development and implementation of these low-cost soil moisture sensors, these are the next steps:

- Development of sensors to read VWC instead of millivolts
- Test sensors in different areas and soil types
- Simplification of online access and interface
- Refine temperature correction algorithm
- Eliminate noise in data through additional hardware and/or use of smoothing algorithms such as localized regression (e.g., LOESS curve)