Assessing Soil Health in the inland Pacific Northwest Agro-ecosystems

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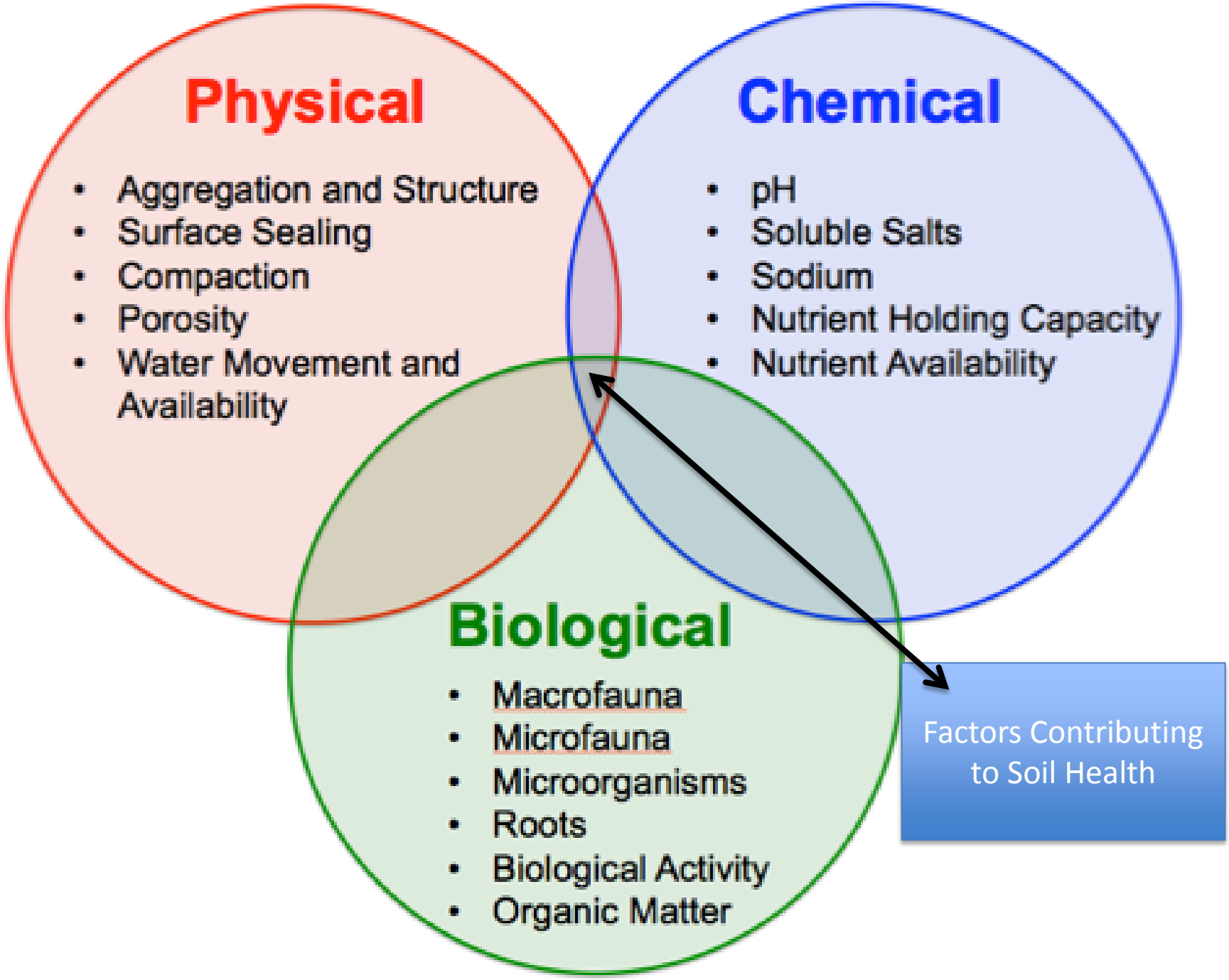
REACCH
Regional Approaches to Climate Change - Pacific Northwest Agriculture

Soil Quality:

- Simply, the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Why is sustaining soil quality important?

"Soil erosion is second only to population growth as the biggest environmental problem the world faces," said David Pimentel, professor of ecology at Cornell. "Yet, the problem, which is growing ever more critical, is being ignored because who gets excited about dirt?"


Physical
Aggregation and Structure
Surface Sealing
Compaction
Porosity
Water Movement and Availability
Chemical
pH
Soluble Salts
Sodium
Nutrient Holding Capacity
Nutrient Availability
Biological
Macrofauna
Microfauna
Microorganisms
Roots
Biological Activity
Organic Matter
Factors Contributing to Soil Health

Project Details

This project serves to initiate long term monitoring for regionalized soil quality indicators. This will be done by:

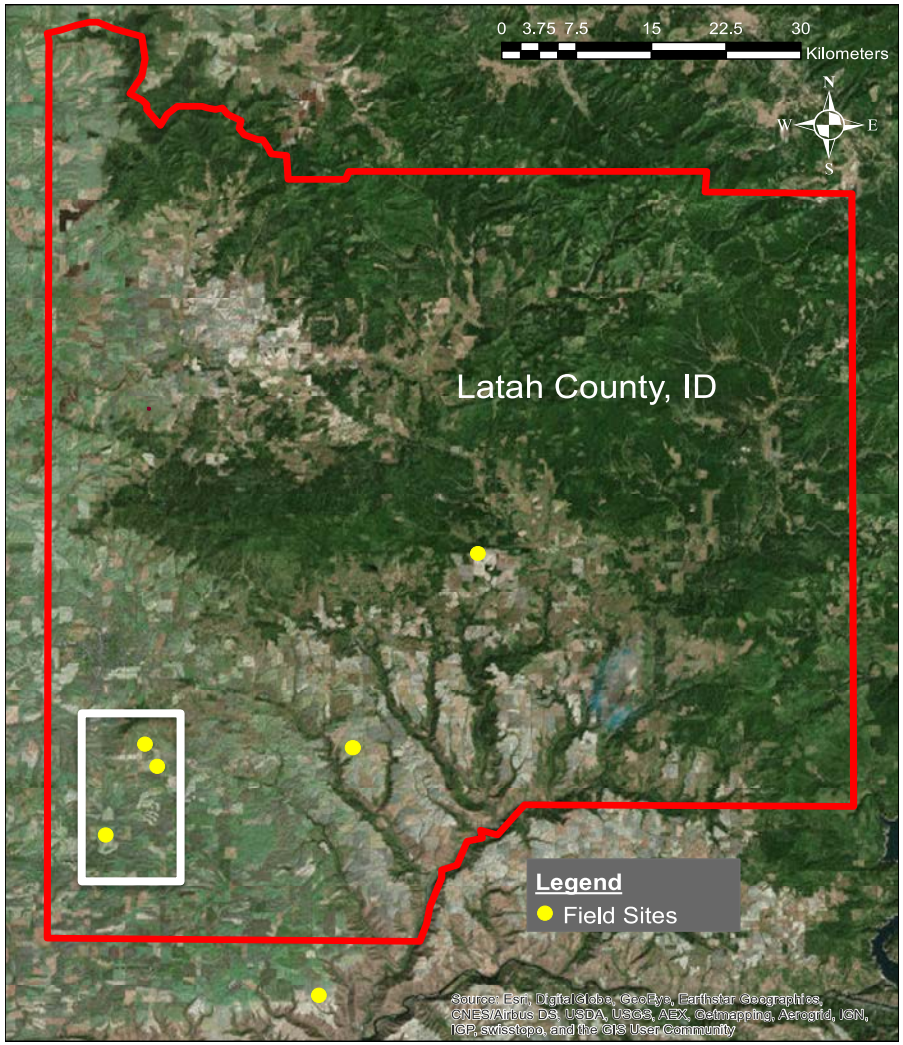
- (i) Performing annual soil health tests (3 yrs)
- (ii) Evaluate and regionalize soil health indicator values under a range of different management systems
- (iii) Develop guidance on soil health monitoring methods that are applicable to farm management decisions in the Palouse

With a current lack of relationship, this will mean combining:

- Indicator values
- Specific soil function
- The implication of management practices

- The Latah county conservation districts Board of Supervisors and farmers have identified the following as soil health priority concerns in conservation ag systems:
  - Soil acidification
  - Soil compaction
  - Declining organic matter

Overview of sites

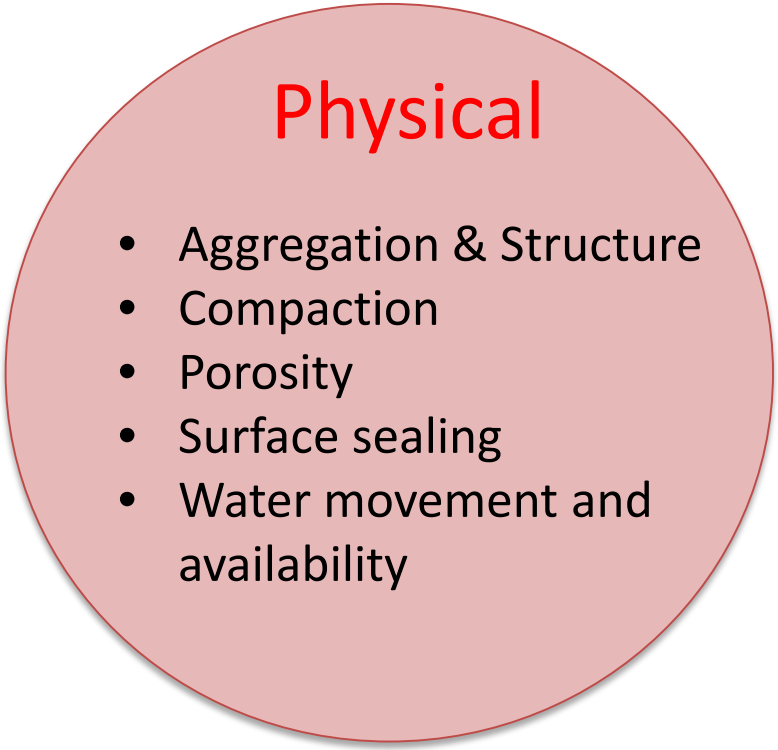


- 4 farms
- 3-4 Fields at each farm
- 2 Sites at each field
- =26 Sampling locations

The sites were mainly chosen per the growers recommendation as areas deemed either problematic or exceptional in production.

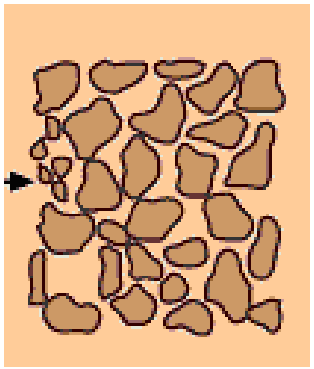
My role in this research

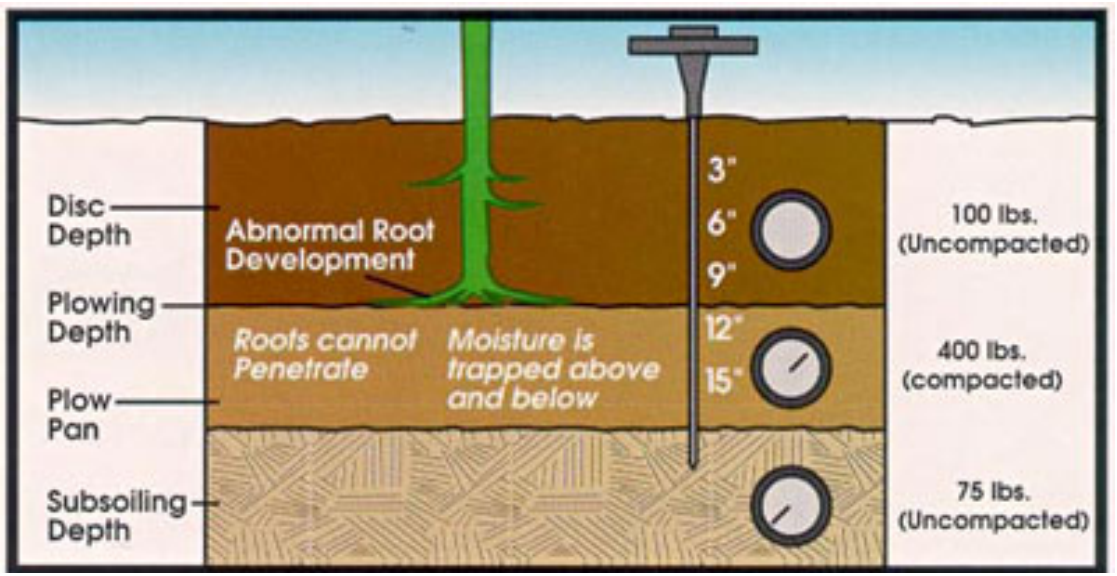
- As it relates to the soil health priority concerns, I've assessed the following physical aspects of soil health:
  - Water holding Capacity
  - Bulk Density
  - Penetration Resistance
    - (compaction)



Soil structure & compaction:

- When a force is applied to a soil it displaces air and water causing compaction by collapsing the pore spaces.





Saturation

Field Capacity (-1/3 bar)

- Water holding capacity Is the total amount of water a soil can hold at or near saturation

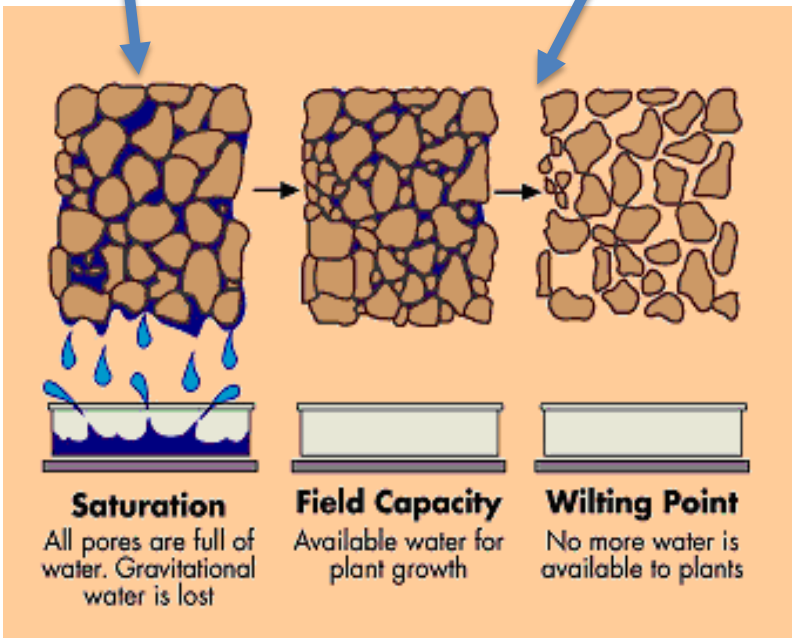


Image Source:**Source: Dept of Agriculture Bulletin 462, 1960**

- FC is a measure of a soils WHC after saturation and all gravitational water drains
- -1/3 bar pressure in the laboratory
- Or 24-48 hours of free draining in a field setting

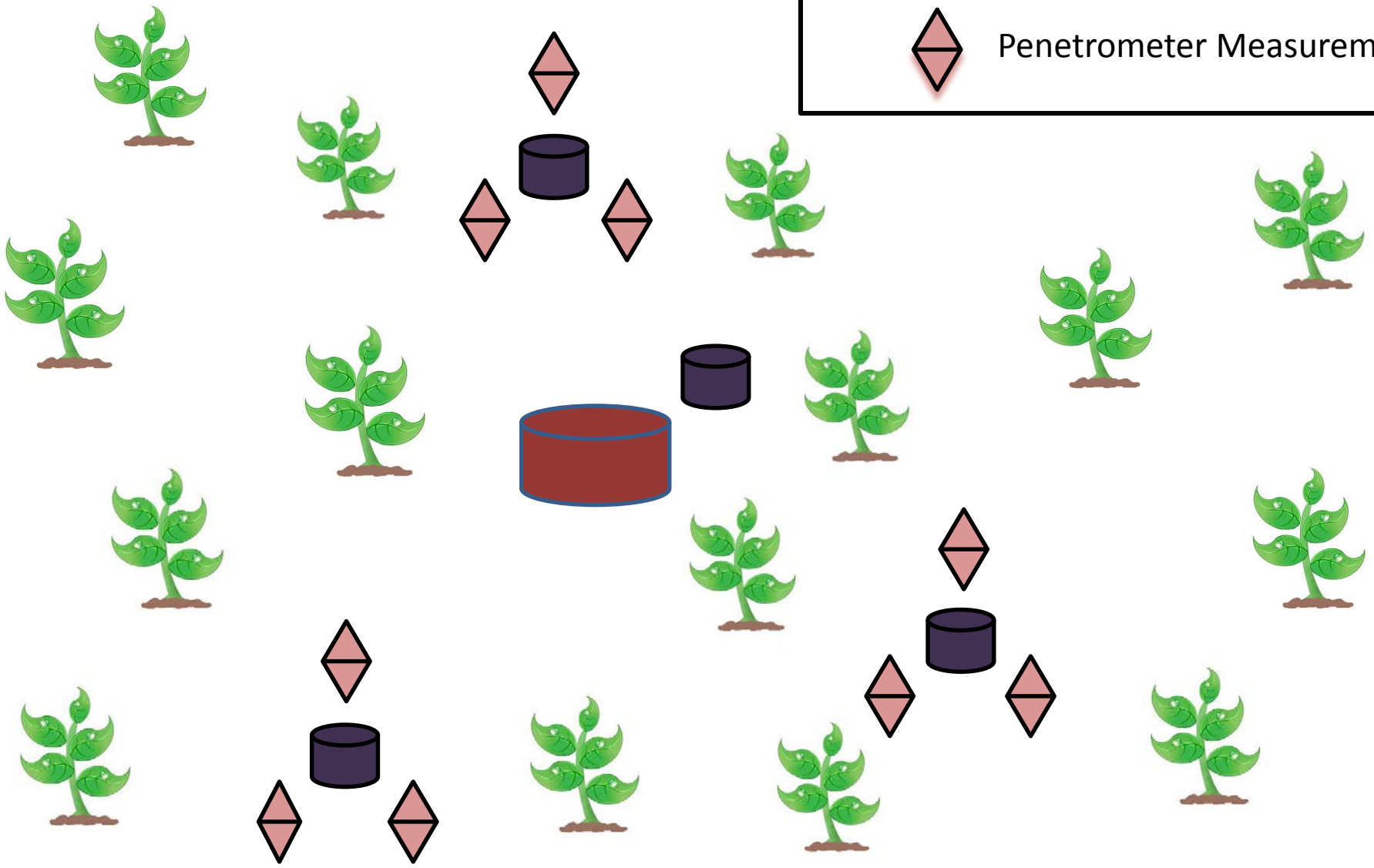
WHC & Field capacity

- This is important for growers because the Palouse prairie soils act as a reservoir by storing winter and spring rain.
- seasonal rain is all that will be available to growing plants during the critical dry growing months (May-July).

Research Questions

1. (Given the importance of water in dryland farming) Is there a rapid WHC test sensitive to farm management differences?
   - Rapid vs lab standard
   - Sample preparation
     - 2mm sieved vs. intact core
2. How does soil moisture impact penetration resistance (as a measure of compaction)
3. How does Db change through time?

Physical Monitoring Layout for Each Site



Methods

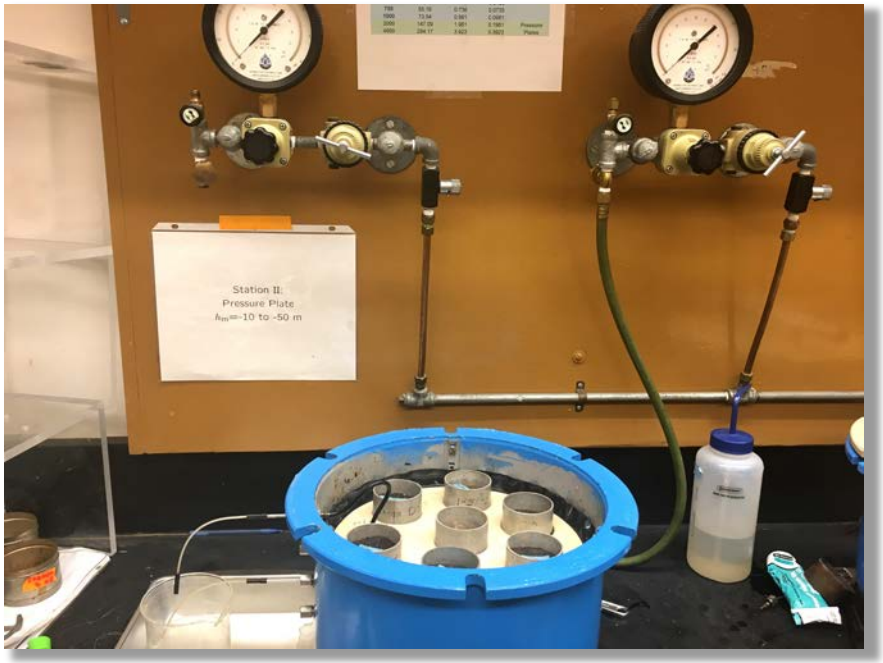
Research Question 1:

Is there a rapid WHC test for growers

-How does lab standard compare to rapid test

Field Capacity: Pressure Plate - The lab standard method

Intact and sieved soil samples were soaked for 24 hours



Saturated soils are placed into a pressurized chamber until equilibrium is reached (at -1/3 bar)

The simple ‘rapid’ water holding capacity method: saturated

Methods:

Research Questions 2:

Penetration resistance was measured using a digital penetrometer (SC 900 Field Scout) & water content on a weight basis (g/g)

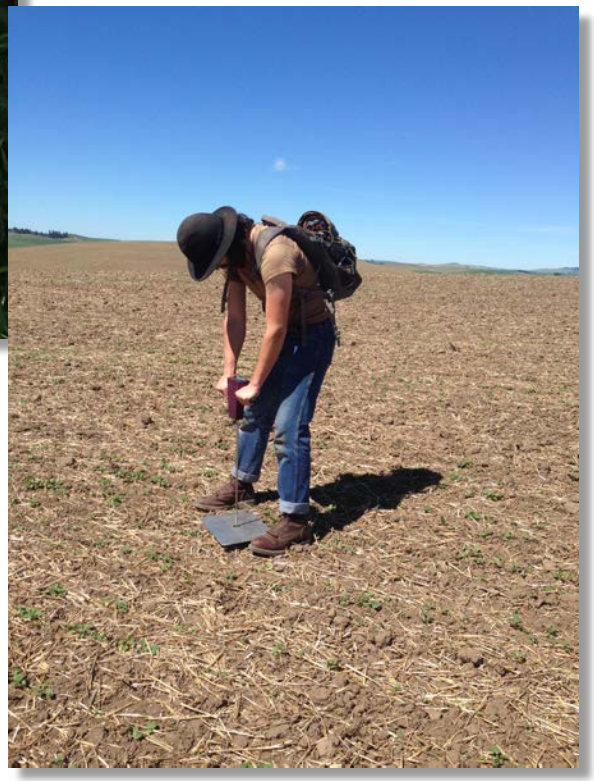
Research question 3:

Bulk density determined at 0-3, 3-6, 6-9 & 9-12 inches, samples taken with soil core

Taking intact cores for WHC

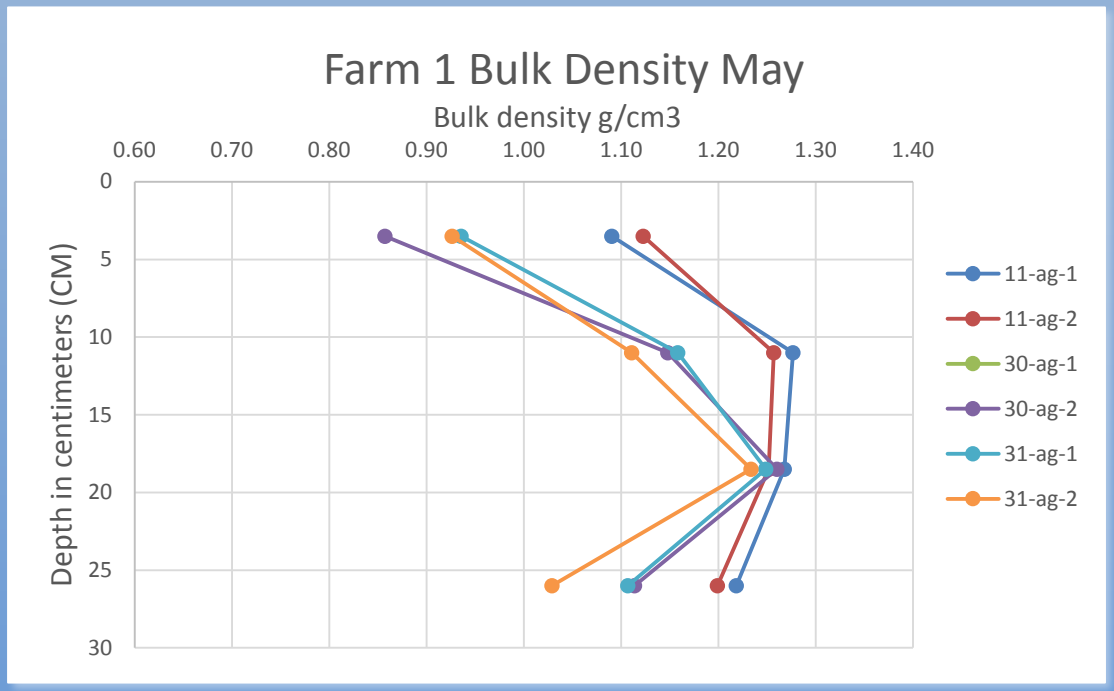
Using the penetrometer to measure PR

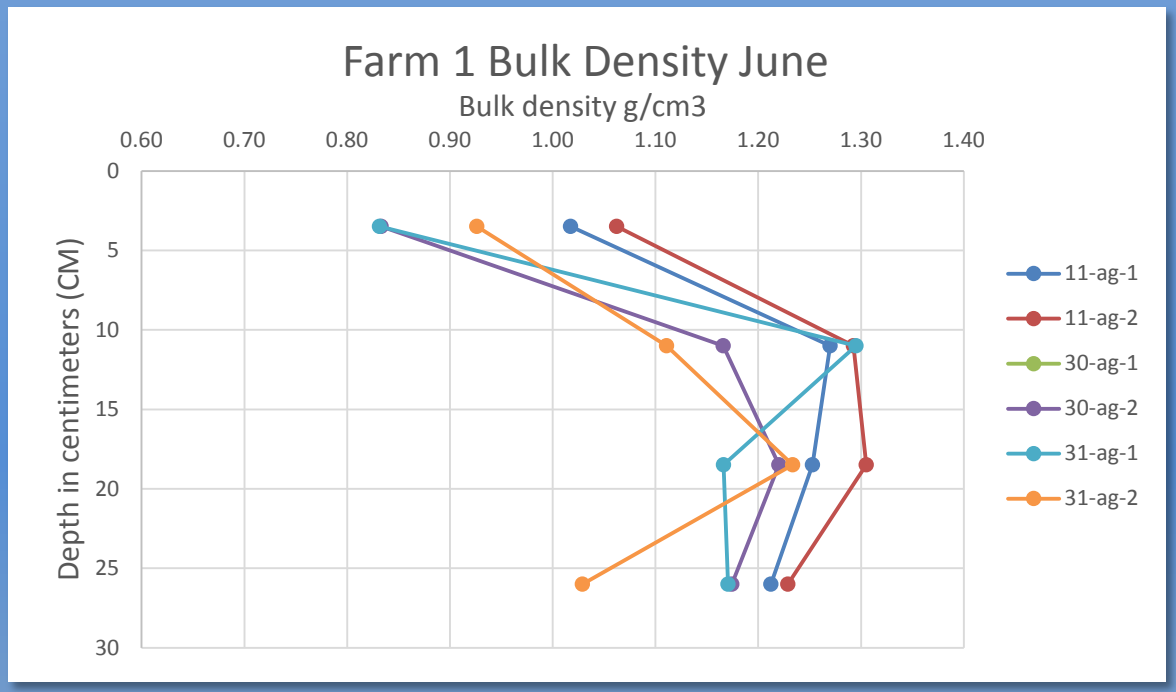
Using soil core for taking Db samples. Each tin is a different depth increment.

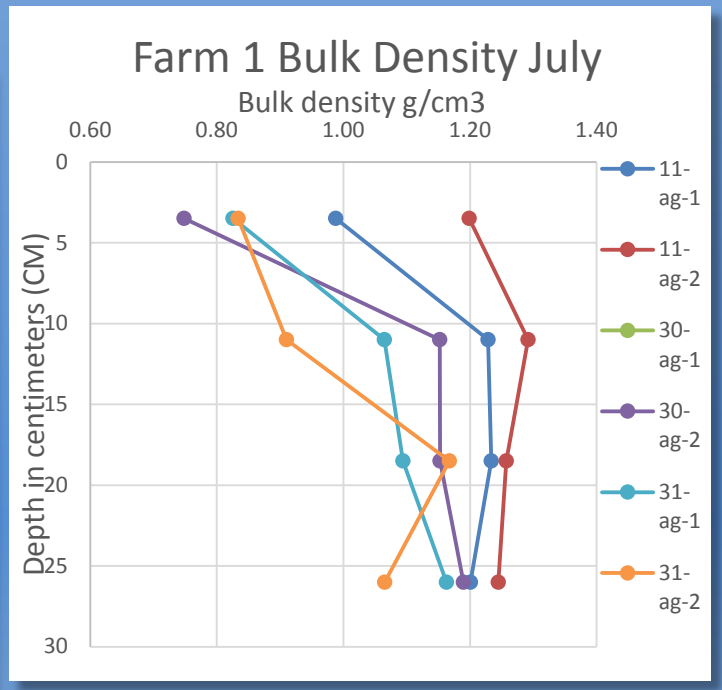


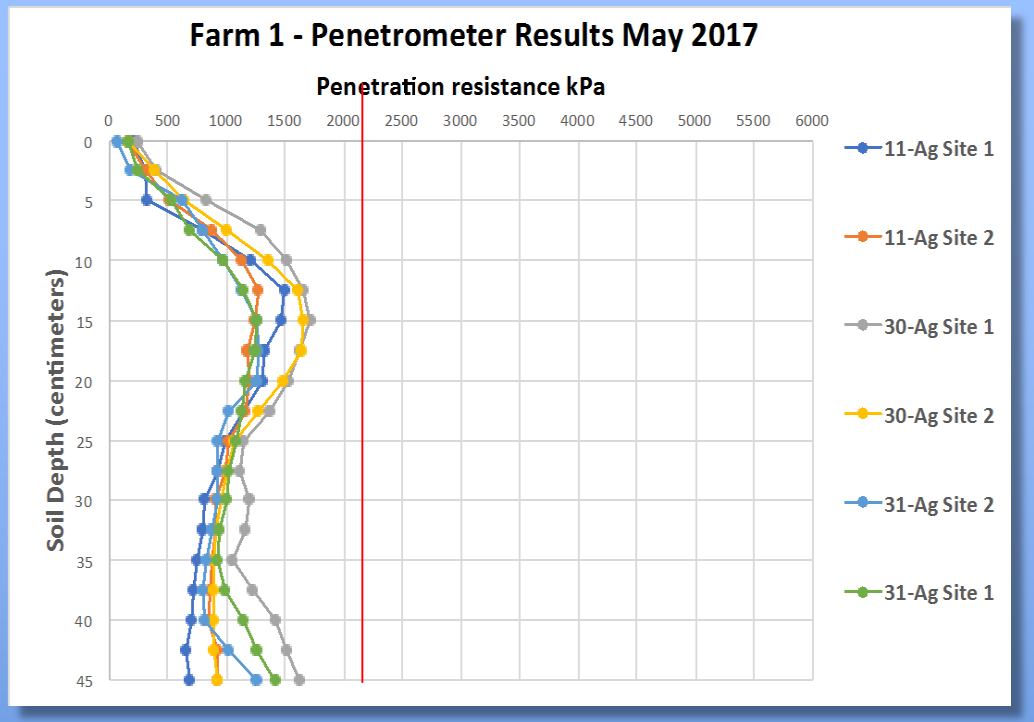

Results

Bulk density on one farm and how it changes through time





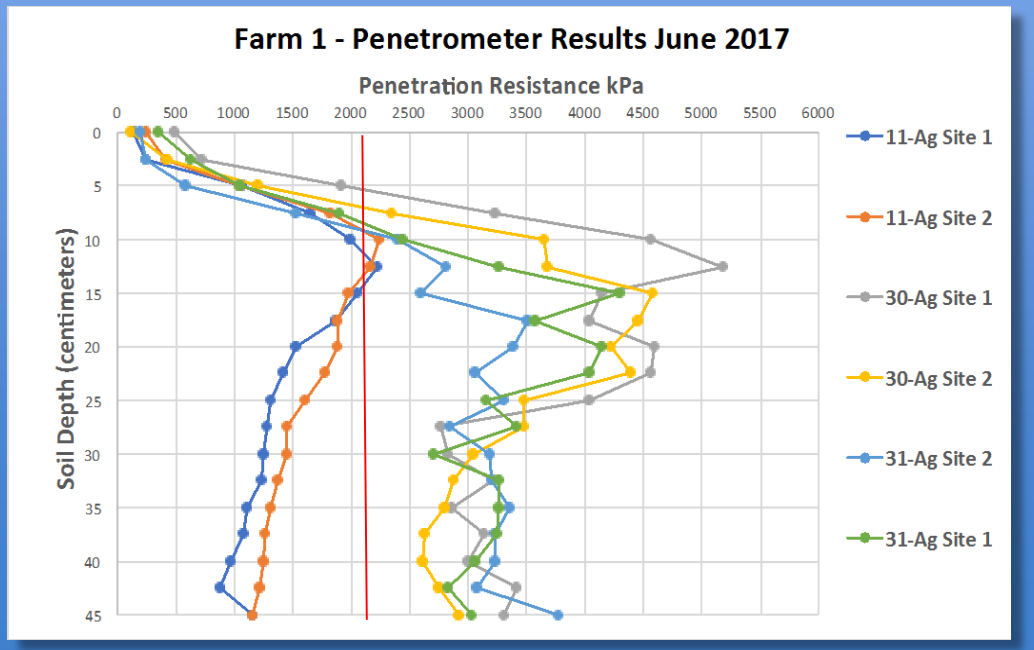


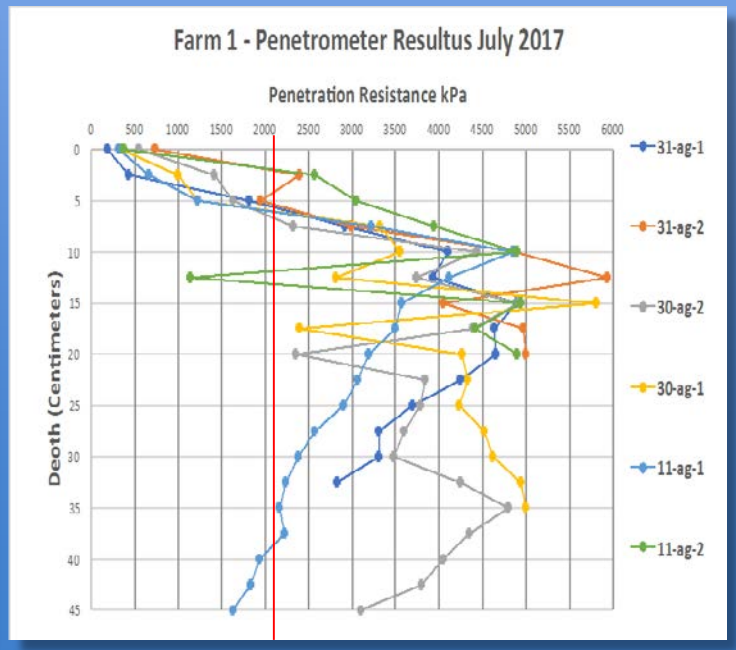


Represents 2068 kPa

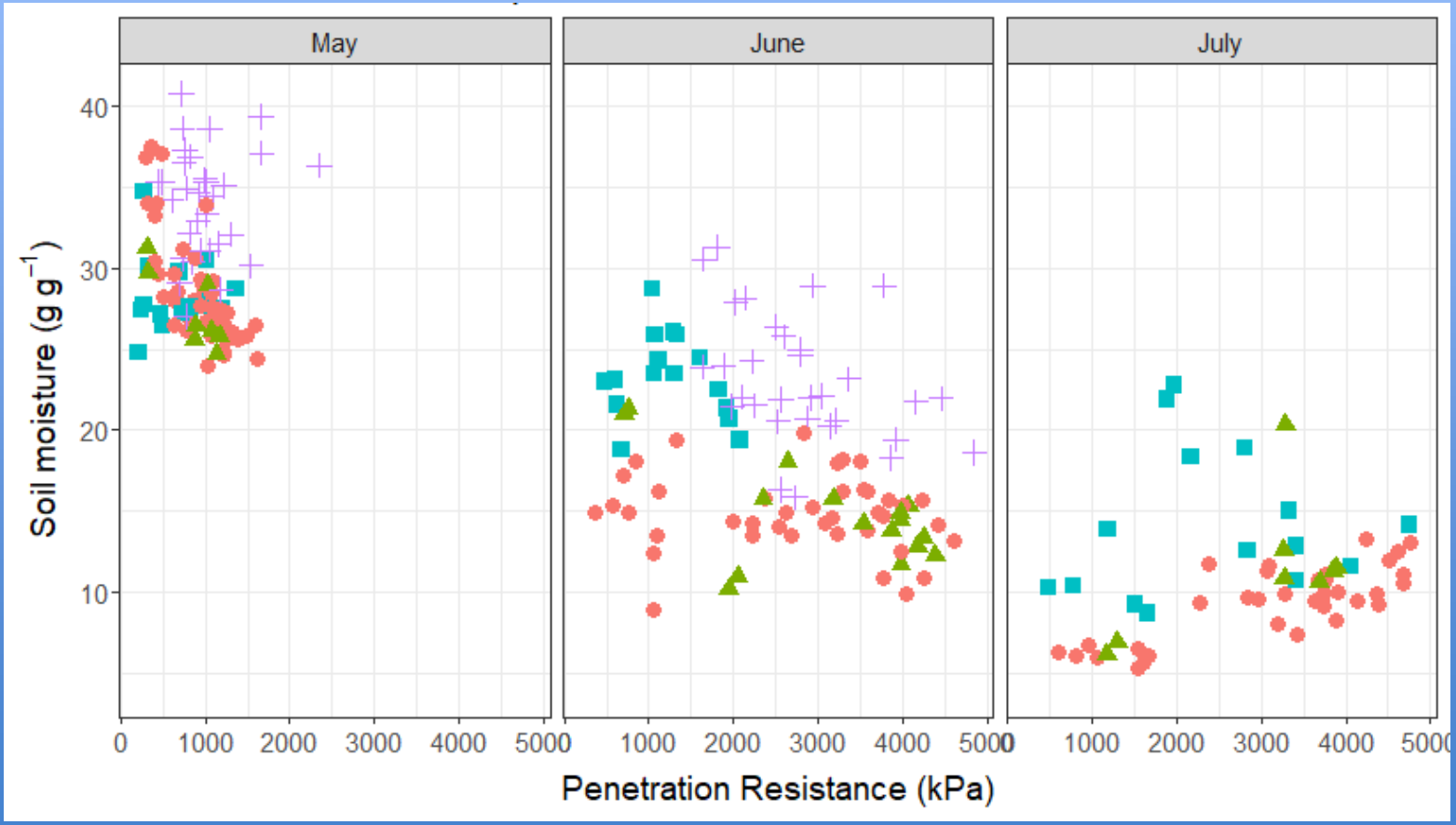
=

Root limiting thresh hold





- Through a statistical analysis it was found that penetration resistance and water moisture is correlated




What is a simple method that is time and cost effective for farmers and extension agents to measure the field capacity of their soils?

Extension:

- I'll be contributing an extension article to the conservation district for a time and cost efficient field capacity method.

- This will be a component of soil health guidelines being developed by the conservation district for growers and land managers

Methods Test

- Evaluating the effectiveness of various soil health monitoring tests and methods pertaining to:
  - A rapid WHC method
  - Pressure plate method
- Undisturbed soil samples vs. disturbed 2mm sieved samples
  - the point is we're looking for a rapid test. So we're looking to measure WHC to see an impact of farm management. Can we measure WHC on a sieved soil, or is it better to take it on an intact core?
  - The next step is to further analyze our results to make any conclusions

Soil Field Capacity

The purpose of this study is to determine if field capacity (FC) soil moisture content can be used to compare soil water characteristics of soils under different agricultural practices. FC is defined as the amount of water held by the soil 24 hours after saturation; this typically equates to the soil water content of a soil under -0.33-bars pressure. In the Palouse region the soils act as a reservoir, holding water for plants through the critical dry and hot summer months.

Understanding soil field capacity and water holding capacity has implications to crop health and yield. Here we explore two sample preparation methods to assess if field capacity is a useful indicator for monitoring the impact of agricultural management or changes in soil quality. Additionally, we compare field capacity measurements to a simple, rapid water holding capacity method that may be appropriate for extension educators or regional soil labs

Methods Procedure: Pressure Plate vs Buchner Funnel

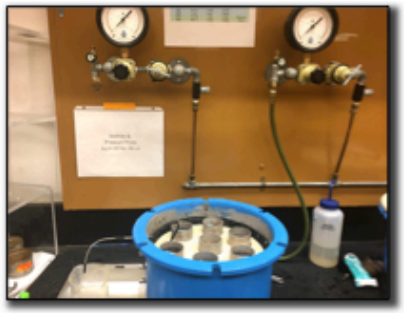
Using the pressure plate method, it provides the consistency of a controlled environment, ensuring the replication of -0.33 bars pressure. Alternatively, the Buchner funnel lacks the controlled environment but is often used in studies for rapid soil water holding capacity determination.

Photo A) Soaking ceramic plate and soil samples

Two methods performed:
(Intact core vs. sieved soil samples)

1) Pressure plate method:
2) Buchner funnel method

(Photo B) Soil samples & ceramic plate in pressure chamber



Pressure plate general method:

1) Soak ceramic plate for six hours. Place soil samples on ceramic plate and soak together for at least sixteen hours *(Photo A)*.
2) Place the ceramic plates with the soils into pressure plate chambers. Apply 1/3 bar pressure and let soils equilibrate for approximately 48 hours. *(Photo B)*.
3) Once equilibrium is reached, weigh wet and place in oven at 105c for 24-36hrs.

This work was supported by the National Institute of Food and Agriculture (NIFA), USDA Award Number:2016-67032-25012

Thank you

The REACCH program

Jodi Johnson-Maynard

Kendall Kahl

Bulk Density:

- **Defined as the weight of soil in a given volume (g/cm^3)**
- **We take bulk density in conjunction with other tests for a variety of reasons:**
  - **To have a known measure of volume for converting units of (depth to area.)**
  - **Determining porosity, WFPS and to have comparable data for compaction trends.**

(iii) Linking soil health indicators to making soil improvements

- Creating a methods manual inspired by Cornell's soil quality indicator handbook.
  - A manual that regionalizes soil quality testing approaches to northern Idaho land management systems.
    - How to quantify improvements, follow potential trends contributing to soil quality depletion or improvements

Soil compaction:

Contribute to the larger soil health project data-set.
How does the rate of soil compaction change through the crucial dry growing months and when is the most accurate time to measure?
This is site specific because of crop types, management practice and seasonal variations.
Can a system for best fit practice be developed?