Assessing Soil Health in the inland Pacific Northwest Agro-ecosystems

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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?"
Factors Contributing to Soil Health

**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)

Physical

• Aggregation & Structure
• Compaction
• Porosity
• Surface sealing
• Water movement and availability
Soil structure & compaction:

- When a force is applied to a soil it displaces air and water causing compaction by collapsing the pore spaces.
• Water holding capacity is the total amount of water a soil can hold at or near saturation.

Saturation

Field Capacity (-1/3 bar)

• FC is a measure of a soil's 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.

Image Source: Dept of Agriculture Bulletin 462, 1960
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

Top 7.5cm intact core
Bulk Density Measurement
Penetrometer Measurement
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 threshold
• 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
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.

Two methods performed: (Intact core vs, sieved soil samples)
1) Pressure plate method:
2) Buchner funnel method

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.
Thank you

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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?