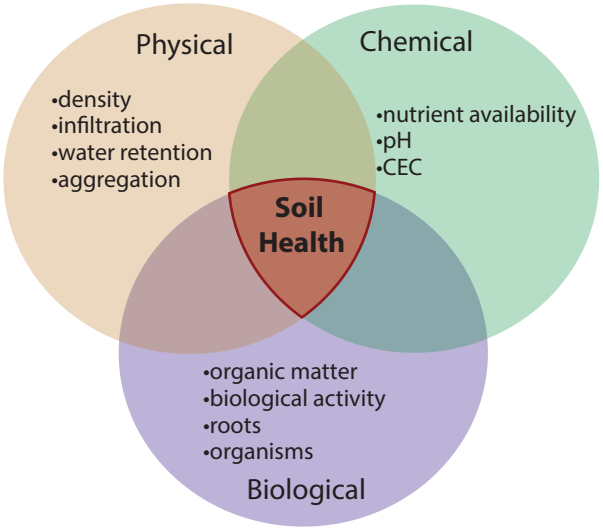
Measuring soil health

April 2019

Soil health is a framework used to evaluate how well a soil is functioning. As displayed in the ven diagram on the right, soil health combines the chemical, physical and biological properties of a soil system. UW Discovery Farms is evaluating biological and physical aspects of soil health. UW Discovery Farms' soil health work spans both the Nitrogen Use Efficiency and Tile Monitoring projects. This handout shares results from three years of biological soil health measurements and one year of soil physical measurements.



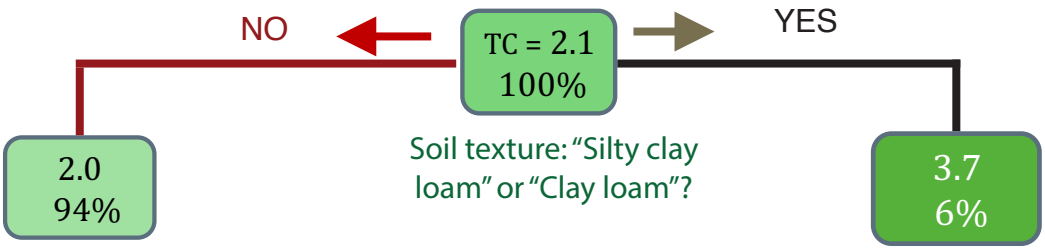
Biological measurements identify which soil properties and management factors influence soil carbon and nitrogen cycling

218 soil samples were collected in the growing seasons of 2015, 2016 and 2017 and tested in the laboratory for biological activity, soil carbon (C), and nitrogen (N) pools. These tests included potentially mineralizable nitrogen (PMN), potentially mineralizable carbon (PMC), permanganate oxidizable carbon (POXC) and total carbon (TC). In addition, short and long-term field history information was gathered through farmer interviews and surveys.

Total carbon is influenced by soil texture

Percentage of total carbon (TC) in 216 soil samples was measured and data were put through a regression tree analysis. Twenty-seven variables were included in this analysis including soil properties, sample timing and management practices. Average TC was 2.1%. TC was most influenced by soil texture. Finer textured soils including silty clay loam or clay loams had an average TC of 3.7% where as coarser textured soils had an average TC of 2.0%.

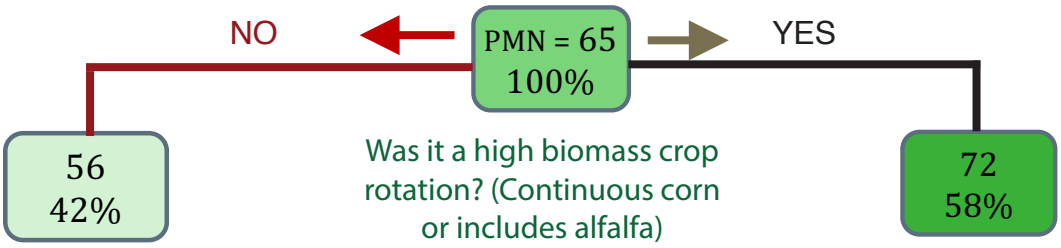
Figure 1. Regression tree of total carbon percentage of 216 soil samples collected from 2015-2017



Labile nitrogen pools are influenced by crop rotation

Regression tree analysis of potentially mineralizable nitrogen (PMN) from our dataset showed the most influential factor we analyzed was crop rotation. Rotations with higher biomass such as continuous corn or including alfalfa in the rotation demonstrated higher PMN values (top number in squares).

Figure 2. Regression tree of PMN (mg N kg $^{-1}$) of 218 soil samples collected from 2015-2017



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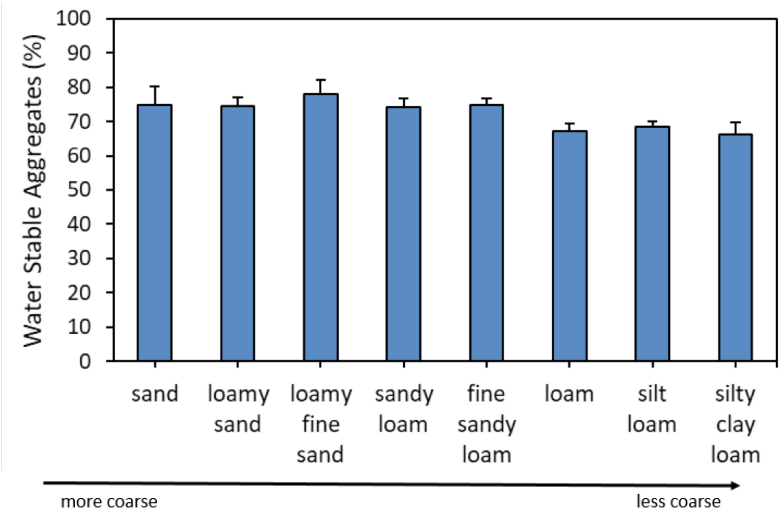
Physical measurements help indicate the health of soil structure

In 2018, Discovery Farms collected physical soil health measurements. At each NUE and Tile monitoring site (total of 75), samples were taken to measure the dry aggregate fractions and water stable aggregates of the soil. At 10 sites, as part of an in depth case study of management practices, a more rigorous evaluation of physical soil health was performed. Evaluations at case study fields included the dry aggregate fraction, water stable aggregates, infiltration rates and water holding capacity.

Water aggregate stability



Each soil sample underwent a test to determine its wet aggregate stability. Soil was placed on a small sieve, and then we created rainfall over them for 5 minutes. The soil that was unstable broke into smaller pieces and fell through the sieve where we could catch it and weigh the amount that was lost. The samples that could withstand this 'rain' event without breaking apart have better aggregate stability than samples that lost a large portion of their soil. This graph shows the portion of soil aggregates that did not break apart (stable aggregates) out of 100%.

Figure 3. Water stable aggregates broken down by soil texture from 75 monitored sites

As soil organic matter (SOM) increases, so does the larger sized aggregate fractions

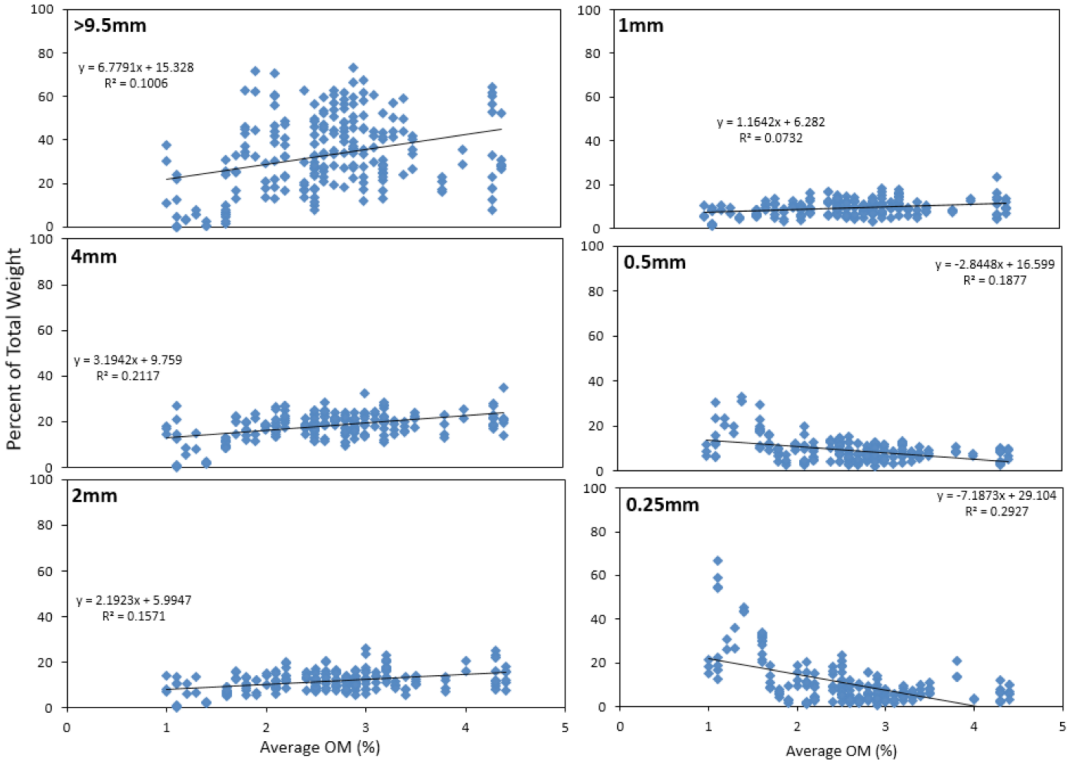


Figure 4. Break-down of soil aggregate size by average SOM and percentage of total weight

Information of different sized aggregates in soil helps us understand the physical structure and relative pore sizes in a soil. An entire air-dried soil sample was passed through six different size sieves (9.5mm, 4mm, 2mm, 1mm, 0.5mm, 0.25mm) to see the different aggregate size portions. These graphs show the amount of aggregates at each size, as a percentage of the total weight of the sample used; the six sizes of each sample add up to equal 100%. A general trend in these data show that as SOM increases, so does the larger sized aggregate fractions. This might imply that soils with a higher fraction of large aggregates will have a greater infiltration and water holding capacity.