Digging deeper into soil health

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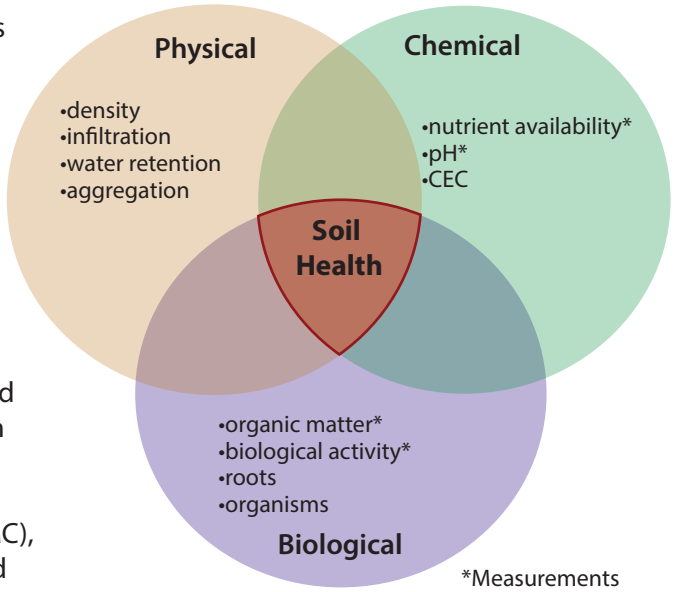
Soil health is a framework used to evaluate how well a soil is functioning. It is similar to evaluating the quality of a soil, but in order to have health it must be alive. Therefore, soil health tends to emphasize that soils are full of life (e.g. bacteria, fungi, protozoa). As displayed in the ven diagram on the right, soil health combines the chemical, physical, and biological properties of a soil system.

UW Discovery Farms is evaluating the biological aspects of soil health, primarily how they impact microbial activity, the associated decomposition of organic matter, and the resulting release of nutrients that can contribute to the fertility of farm fields.

UW Discovery Farms' soil health work spans both the Nitrogen Use Efficiency and Tile Monitoring projects. 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. Three tests were chosen to highlight the labile C and N that cycle quickly through the soil. These tests included potentially mineralizable nitrogen (PMN), potentially mineralizable carbon (PMC), and permanganate oxidizable carbon (POXC). In addition, short and long-term field history information was gathered through farmer interviews and surveys.



*Measurements included in this Discovery Farms study.

Goal: Identify which soil properties and management factors influence soil carbon and nitrogen cycling the most

Discovery Farms is interested in how various soil properties and management factors influence soil health measurements. Variables indicated below are included in the analysis. Data has been gathered through farmer surveys and interviews, as well as standardized laboratory analysis.

Management Factors

Cover crops
Number of years with cover in the last 5 years.

Tillage
No-till= drills and planters
Reduced till= vertical or stip tillage
Conventional till= chisels, moldboard, discs, and cultivators

Manure inputs
Years since first application, applied how many of last 5 years?

Rotation
CC, CS, CSW, COA, other
C=corn, S=soy, W=wheat, O=oats, A=alfalfa

Soil Properties

pH

Soil texture

Drainage class

With many variables, standard analysis is inconclusive

The 218 farm fields in this study represent a large variety of soils, cropping systems, and management practices. While most research only changes one variable at a time, here all of the variables can change simultaneously from field to field. As a result, there is a lot of noise in the data that makes the results of standard analysis less meaningful. On the following page, we use a multivariate analysis that is more appropriate for this dataset.

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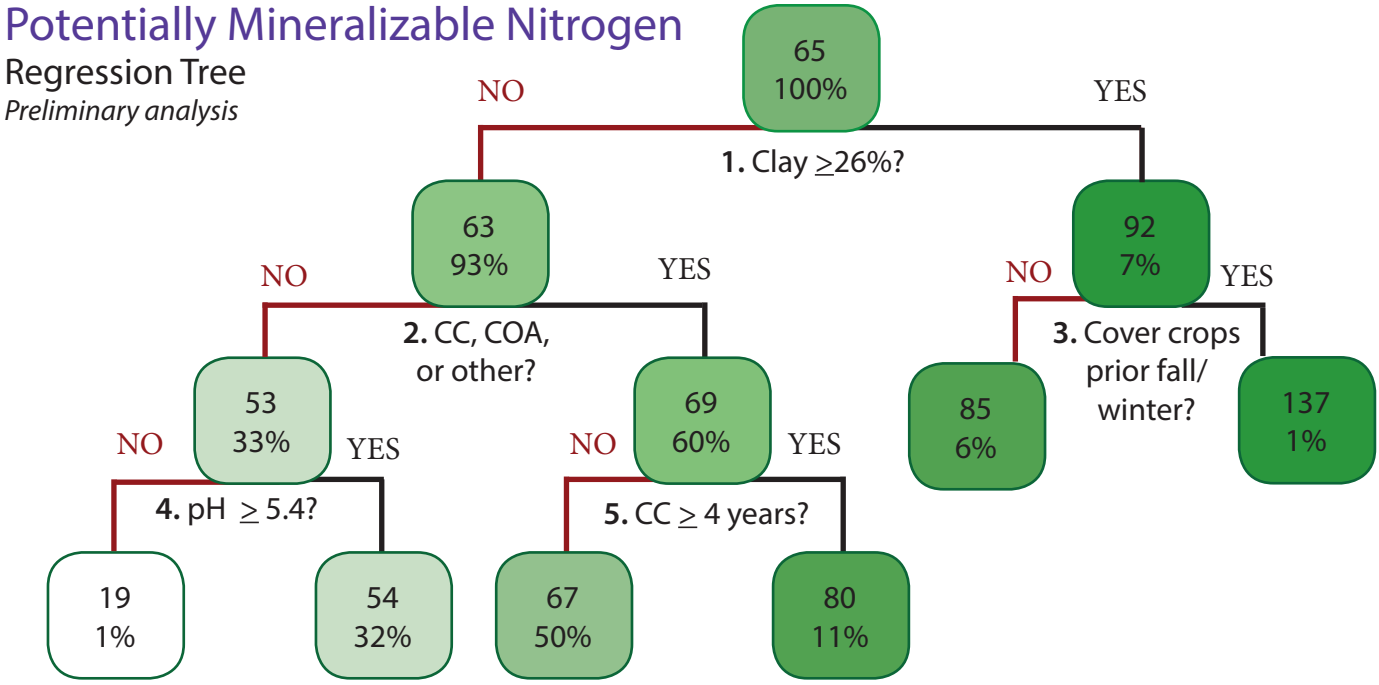
To incorporate multiple variables, we are using regression tree analysis

A regression tree is a statistical model that evaluates how multiple variables influence one outcome. Starting with the average of all of the data points, the model splits everything into two groups that are distinct from one another. These new groups can be split again and again in the same fashion. The final result reveals factors that are most influential in explaining the values in one outcome.

The below regression tree uses potentially mineralizable nitrogen (PMN) values from the UW Discovery Farms dataset. PMN is an indicator of the natural nitrogen supplying capacity of a soil. The top number in each box is the average of the measured value (PMN) for all of the samples and the bottom number is the percentage of the total number of samples. See the table for an explanation of this preliminary analysis of PMN.



1. Soils with higher clay content tend to build more organic matter. This results in larger pools of organic nitrogen that can be mineralized.	**2.** Higher biomass crop rotations (e.g. continuous corn, corn-oat-alfalfa) add more organic nitrogen to the system, which mineralizes over time.
3. Cover crops take up excess nitrogen in the off-season and their residues are organic sources of nitrogen that can increase mineralization over the long term.	**4.** Acidic soils can inhibit mineralization.
5. Fields grown as continuous corn for the past 4+ years had higher PMN values. This may be due to the higher biomass in the residue, or that these rotations are typically used in higher quality fields with more organic matter.	

What next?

There are questions that remain unanswered such as **what is considered a good number?** Our findings show that the answers will depend on the soil texture of a field, as well as the type of rotation being implemented.

Complementary research is underway to run the same soil health tests on soils from long-term research station trials. Moving forward, we will compare long term research station results to our data and continue building our database.