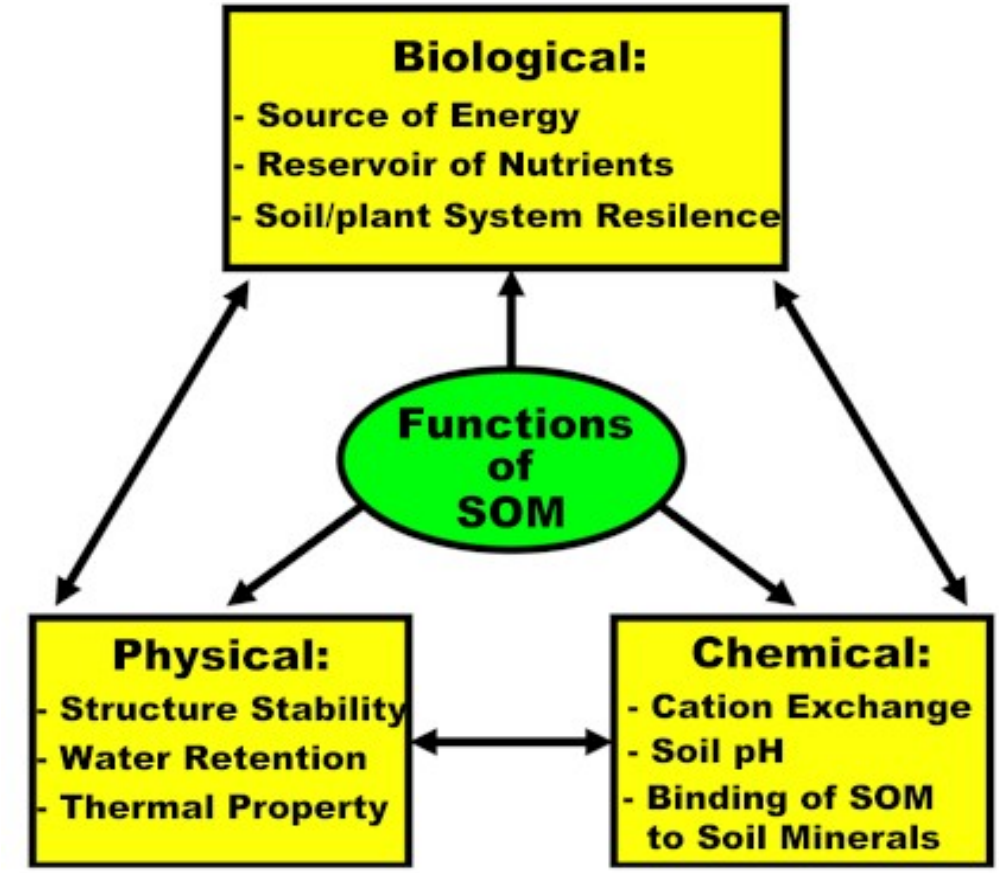
Evaluating Cover Crops Effects on Soil Organic Matter and its Fractions

By Zoe Heuermann

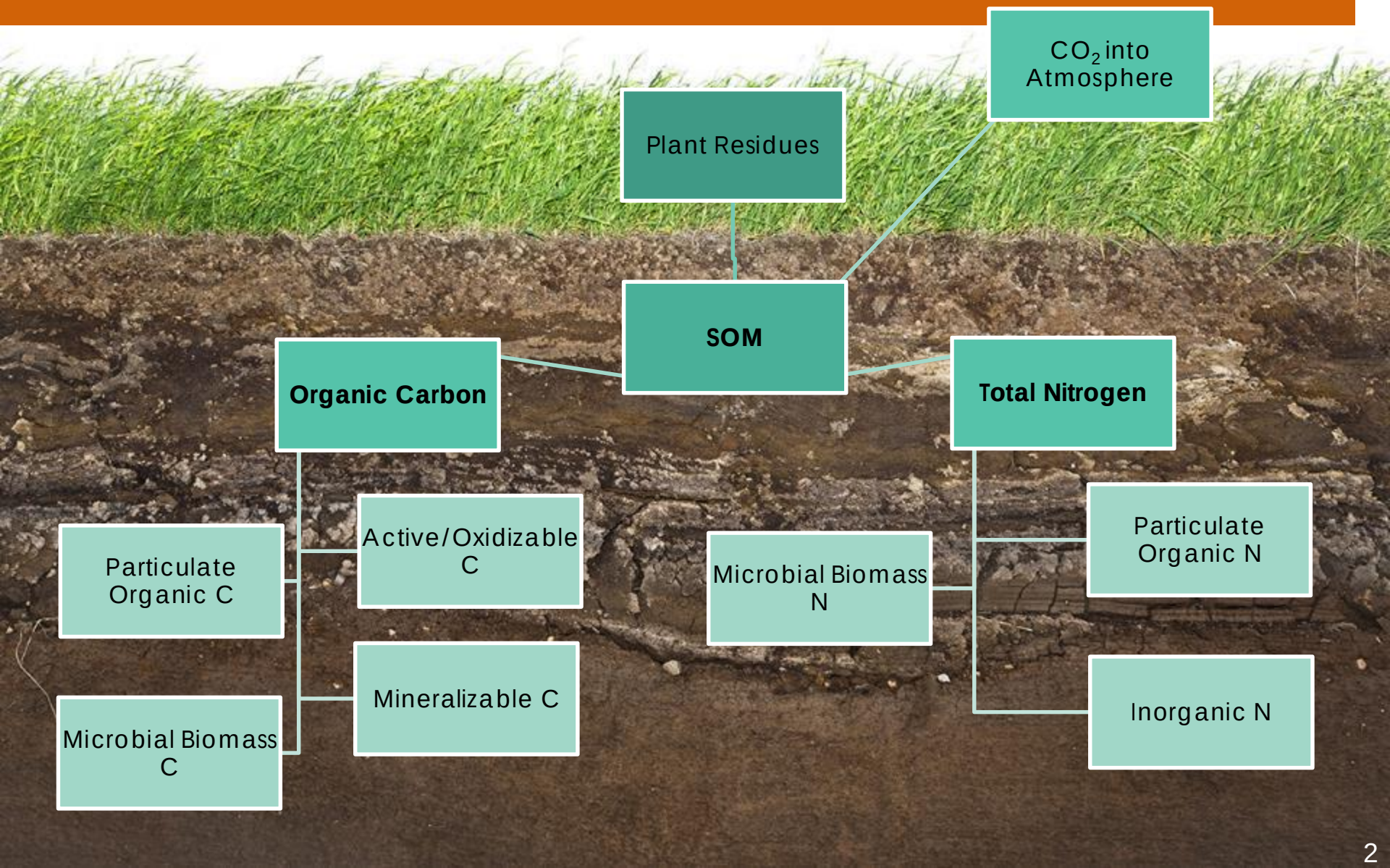
Soil Organic Matter (SOM)

- SOM is measured as an important indicator of soil health
  - Changes in SOM take years to manifest
  - Thus, scientists measure the more sensitive fractions of SOM



http://www.treepower.org/soils/soilorganicmatter.html

SOM Fractions



Wheat-Fallow Cropping System

- Continued use of fallow depletes SOM
- Figure: Soil organic carbon depletion over the course of 79 years under a what-fallow system at the Columbia Basin Agricultural Research Station near Pendleton, OR

Adapted from Machado 2011 and Ghimire *et al.*, 2015

Purpose of the Experiment: To determine…

Ida Gold Mustard (*Sinapis alba*)

- Effects of covers crops on SOM buildup
- SOM fractions sensitive to SOM dynamics under different cover crop treatments
- Trends between depths and the SOM fractions
- Correlations between SOM fractions

Lenetah barley (*Hordeum vulgare)*

Austrian Winter Pea (*Pisum sativum)*

Wheat-Cover Cropping System

- Summer 2014 at the Columbia Basin Agricultural Research Station near Pendleton, OR
- 30 plots (90x20 ft) under no tillage
- Loam type soil

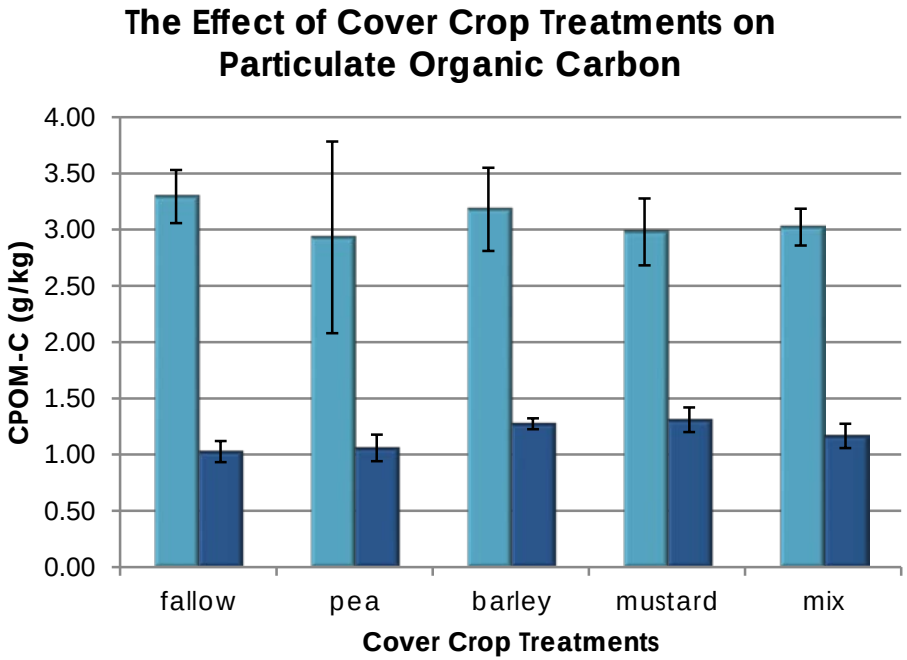
Experimental Design		
Main Treatment	**Plots**	**Sub Treatment**
Cover Crop	1	Fallow
	2	Pea
	3	Mix
	4	Barley
	5	Mustard
Wheat	6	Mustard
	7	Mix
	8	Barley
	9	Pea
	10	Fallow

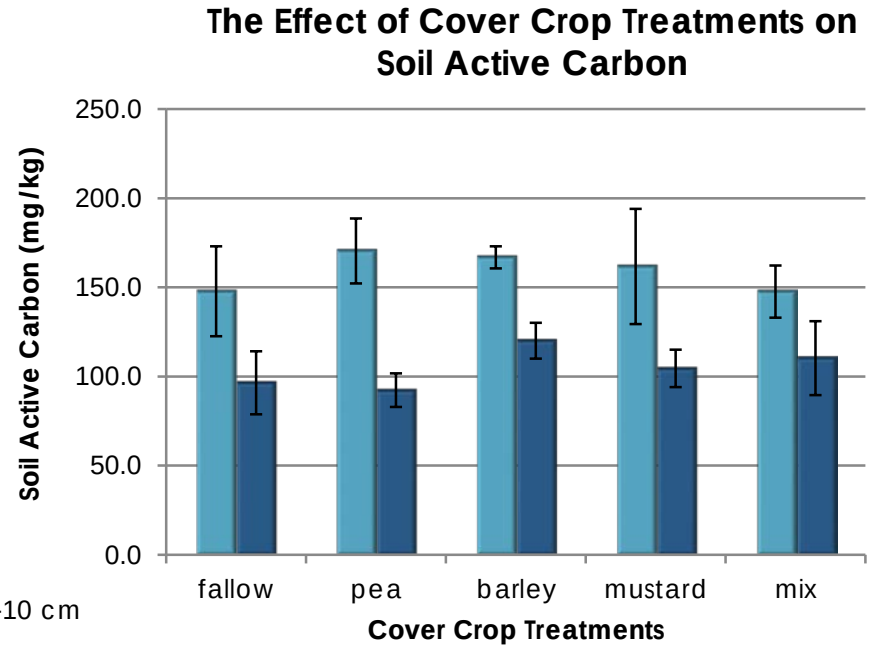
Wheat-Cover Cropping System

- Soil samples (0-10 cm and 10-20 cm) were collected on June 20th and 21st, 2017
- Air-dried and passed through 2 mm sieve
- Measured general soil health parameters and SOM fractions

Effects of Cover Crop Treatments on SOM and its Fractions

- No significant differences found in SOM and its fractions between the cover crop treatments





0-10 cm

10-20 cm

Trends between Soil Depths

- The upper depth (0-10cm) has more organic matter than the lower depth (10-20cm)
- No consistent trends between depths and treatments in the measured fractions
  - Important to sample at different soil depths

Correlations between SOM Fractions (0-10 cm)

	Soil Organic Carbon	Total Nitrogen
Particulate Organic C	0.74***	0.65***
Particulate Organic N	0.62***	0.55**
Mineralizable C	0.80***	0.63***
Active/Oxidizable C	0.14^{ns}	0.19^{ns}

*p ≤ *0.05;* **p ≤ 0.01; ***p ≤ 0.001; ns = not significant

Values represent Pearson's r value

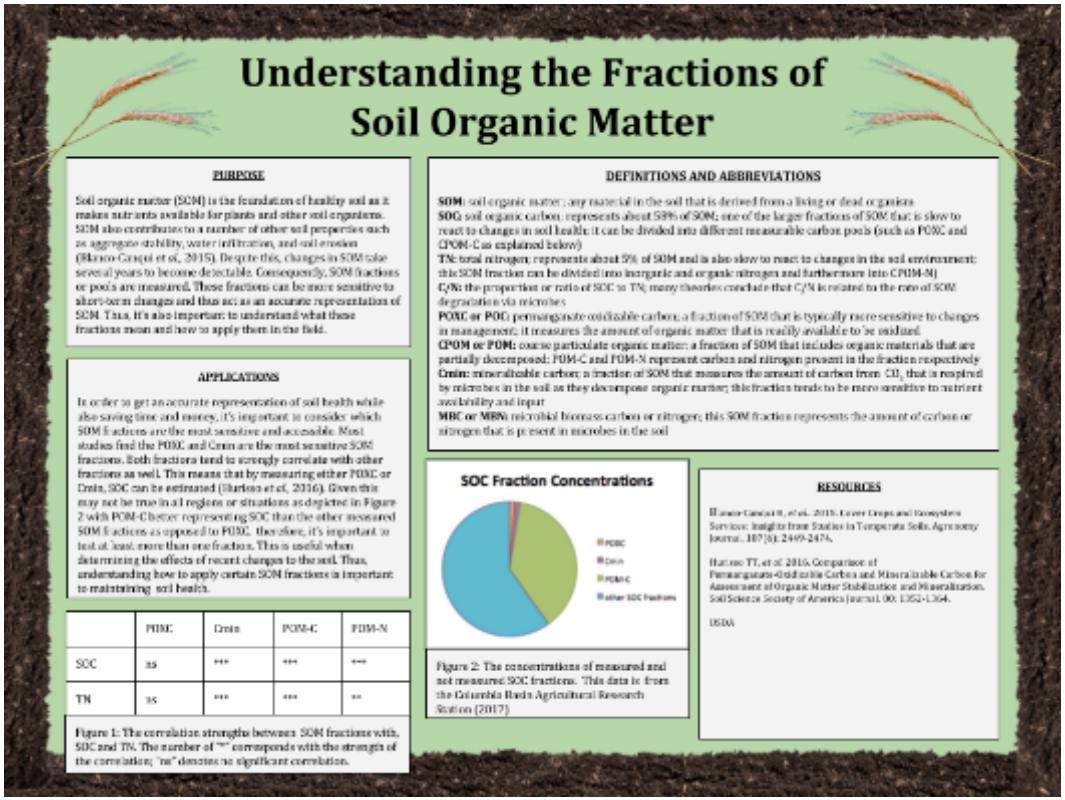
Conclusions

- No differences in SOM and its fractions among cover crop treatments
- There is more SOM in the 0-10 cm depth than 10-20 cm depth
  - Sample soils at different depths
- Highly significant correlations between SOM fractions
  - Mineralizable carbon and Particulate organic carbon
  - More sensitive fractions can estimate less sensitive fractions

- More SOM fractions to measure
  - Inorganic N and Microbial Biomass

Extension Product

- Informative poster explaining SOM and its fractions
  - Definitions
  - Applications while considering accessibility
  - Sources for more information about SOM
- Audience:
  - Agricultural scientists
  - Growers in the PNW
  - Environmentalists and policy makers



Understanding the Fractions of Soil Organic Matter

PURPOSE

Soil organic matter (SOM) is the foundation of healthy soil as it makes nutrients available for plants and other soil organisms. SOM also contributes to a number of other soil properties such as aggregate stability, water infiltration, and soil erosion (Blanco-Canqui et al., 2015). Despite this, changes in SOM take several years to become detectable. Consequently, SOM fractions or pools are measured. These fractions can be more sensitive to short-term changes and thus act as an accurate representation of SOM. Thus, it's also important to understand what these fractions mean and how to apply them in the field.

APPLICATIONS

In order to get an accurate representation of soil health while also saving time and money, it's important to consider which SOM fractions are the most sensitive and accessible. Most studies find the POXC and Cmin are the most sensitive SOM fractions. Both fractions tend to strongly correlate with other fractions as well. This means that by measuring either POXC or Cmin, SOC can be estimated (Hurtado et al., 2016). Given this may not be true in all regions or situations as depicted in Figure 2 with POM-C better representing SOC than the other measured SOM fractions as opposed to POXC, therefore, it's important to test at least more than one fraction. This is useful when determining the effects of recent changes to the soil. Thus, understanding how to apply certain SOM fractions is important to maintaining soil health.

	POXC	Cmin	POM-C	POM-N
SOC	ns	***	***	***
TN	ns	***	***	**

Figure 1: The correlation strengths between SOM fractions with SOC and TN. The number of "*" corresponds with the strength of the correlation; "ns" denotes no significant correlation.

DEFINITIONS AND ABBREVIATIONS

SOM: soil organic matter; any material in the soil that is derived from a living or dead organism

SOC: soil organic carbon; represents about 58% of SOM; one of the larger fractions of SOM that is slow to react to changes in soil health; it can be divided into different measurable carbon pools (such as POXC and CPOM-C as explained below)

TN: total nitrogen; represents about 5% of SOM and is also slow to react to changes in the soil environment; this SOM fraction can be divided into inorganic and organic nitrogen and furthermore into CPOM-N)

C/N: the proportion or ratio of SOC to TN; many theories conclude that C/N is related to the rate of SOM degradation via microbes

POXC or POC: permanganate oxidizable carbon; a fraction of SOM that is typically more sensitive to changes in management; it measures the amount of organic matter that is readily available to be oxidized

CPOM or POM: coarse particulate organic matter; a fraction of SOM that includes organic materials that are partially decomposed; POM-C and POM-N represent carbon and nitrogen present in the fraction respectively

Cmin: mineralizable carbon; a fraction of SOM that measures the amount of carbon from CO_2 that is respired by microbes in the soil as they decompose organic matter; this fraction tends to be more sensitive to nutrient availability and input

MBC or MBN: microbial biomass carbon or nitrogen; this SOM fraction represents the amount of carbon or nitrogen that is present in microbes in the soil

SOC Fraction Concentrations

Figure 2: The concentrations of measured and not measured SOC fractions. This data is from the Columbia Basin Agricultural Research Station (2017)

RESOURCES

Blanco-Canqui H., et al., 2015. Cover Crops and Ecosystem Services: Insights from Studies in Temperate Soils. Agronomy Journal. 107(6): 2449-2474.

Hurtado TT, et al. 2016. Comparison of Permanganate-Oxidizable Carbon and Mineralizable Carbon for Assessment of Organic Matter Stabilization and Mineralization. Soil Science Society of America Journal. 00: 1352-1364.

USDA

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