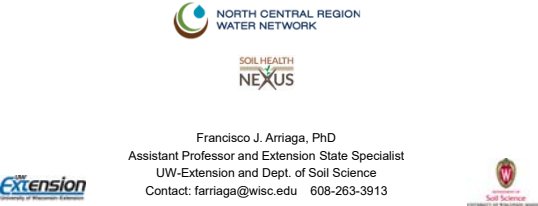


Linking Soil Health to Water Quality



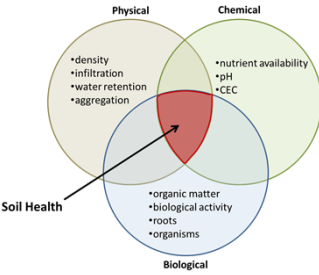
Francisco J. Arriaga, PhD
Assistant Professor and Extension State Specialist
UW-Extension and Dept. of Soil Science
Contact: farriga@wisc.edu 608-263-3913

North Central Region Water Network Webinar Series
June 13, 2018

1

Soil Health Indicators (or Soil Properties that Influence Function)

What is soil health?
Ability of a soil to function in a way that benefits humans and the environment.




2

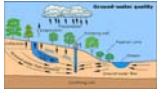
Water Quality Issues

Water Quality Concern

- Surface water
 - Sediment
 - Phosphorus
 - Nitrogen
- Groundwater
 - Nitrogen
 - Pesticides
 - Pathogens



Source: WI Land and Water



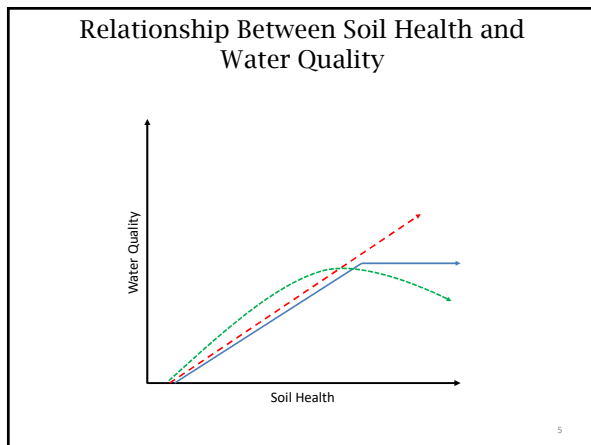
Source: <https://www.learner.org/courses/innocent>

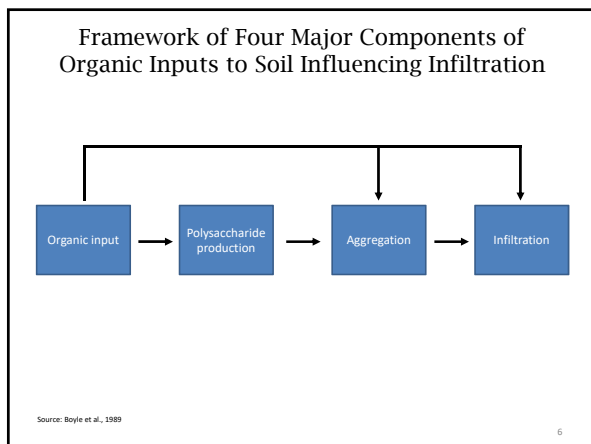
3

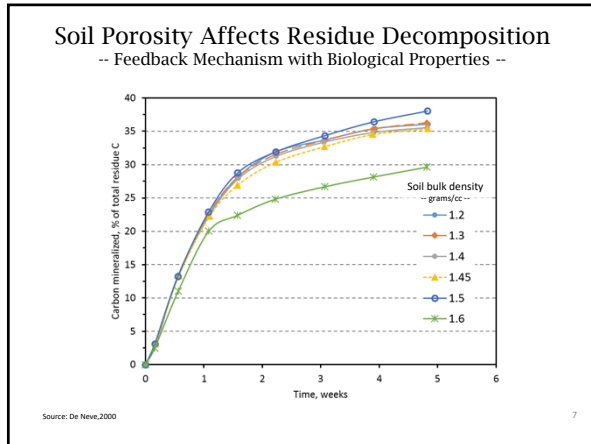
Connecting Water Quality Issues to Soil Health (Function)

| <u>Water Quality Concern</u> | <u>Soil Health Indicator</u> |
|---|---|
| <ul style="list-style-type: none">• Surface water<ul style="list-style-type: none">- Sediment- Phosphorus- Nitrogen • Groundwater<ul style="list-style-type: none">- Nitrogen- Pesticides- Pathogens | <ul style="list-style-type: none">• Surface water<ul style="list-style-type: none">- Runoff/infiltration- Aggregation- Nutrient cycling • Groundwater<ul style="list-style-type: none">- Drainage/water retention- Nutrient cycling- Pesticide breakdown |

4







Enzyme Activity as an Indicator

- Garcia et al. (1997) reported that dehydrogenase activity can be used as a sensitive indicator of soil degradation and microbial activity.
- Dehydrogenase activity of the 18 degraded soils studied was not correlated with soil organic matter content; but it was positively correlated with soil respiration, and biomass carbon.

The scatter plot shows a positive correlation between Dehydrogenase activity and both Soil respiration and Biomass carbon, while there is no significant correlation with Organic matter.

Source: Garcia et al., 1997

Effect of Fungi on Water Stable Aggregates

| Aggregate Size (um) | Water-stable Aggregates (%) | | | |
|---------------------|-----------------------------|-----------|----------------------|-----------|
| | No-tillage | | Conventional Tillage | |
| | Control | Fungicide | Control | Fungicide |
| > 2000 (*) | 66 a | 42 b | 43 | 39 |
| 2000 – 250 | 17 a | 31 b | 20 | 24 |
| 250 – 106 (*) | 6 b | 10 a | 10 | 11 |
| 106 – 53 | 3 b | 6 a | 4 | 3 |
| < 53 (*) | 9 | 11 | 23 | 24 |

Source: Beare et al., 1997

Effect of Fungi on Water Stable Aggregates

| | Total Carbohydrates & Mannose/Xylose Ratio | | | |
|-------------------------------------|--|-----------|----------------------|-----------|
| | No-tillage | | Conventional Tillage | |
| | Control | Fungicide | Control | Fungicide |
| Total carb. (*) (mg per kg soil) | 1,881 a | 1,563 b | 911 | 959 |
| M/X ratio (*) | 2.26 b | 1.50 a | 1.73 | 0.97 |

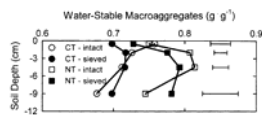
- No difference in soil respiration between tillage managements.

Source: Beare et al., 1997

10

Long-Term and Short-Term Soil Disruption Affects Infiltration and Leaching

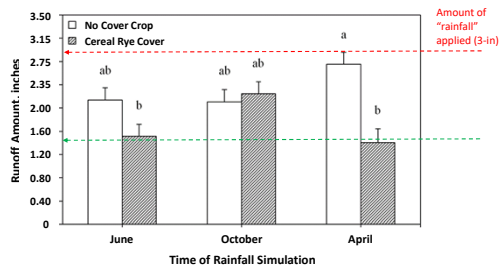
| No-Tillage | | Conventional | |
|--|--------|--------------|--------|
| Intact | Sieved | Intact | Sieved |
| ----- infiltration (cm / hr) ----- | | | |
| 72 a | 28 b | 22 b | 22 b |
| ----- Portion of water leached (ml / ml) ----- | | | |
| 0.33 b | 0.23 c | 0.41 a | 0.32 b |



Source: Franzluebbers, 2002

11

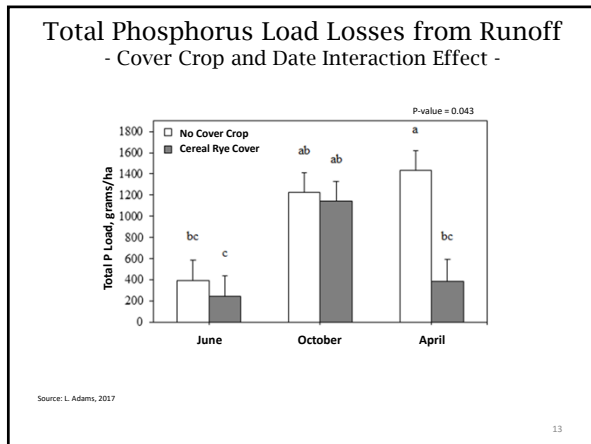
Cover Crops Help Reduce Runoff, but there are Seasonal Differences

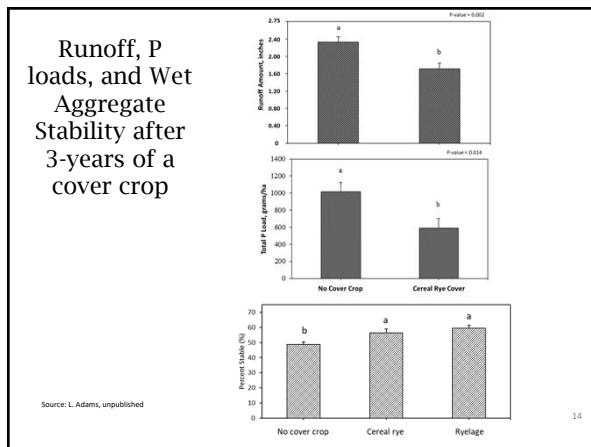


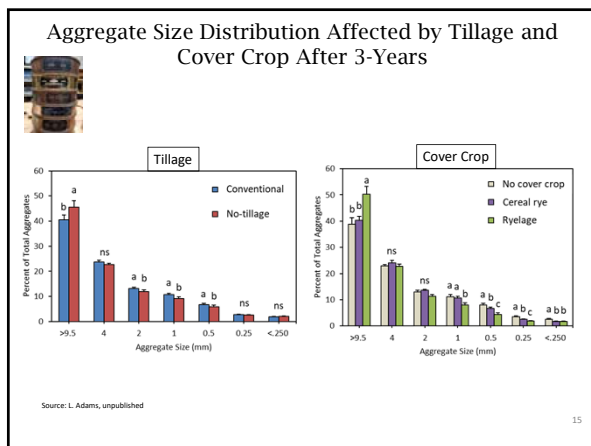
Source: L. Adams, 2017

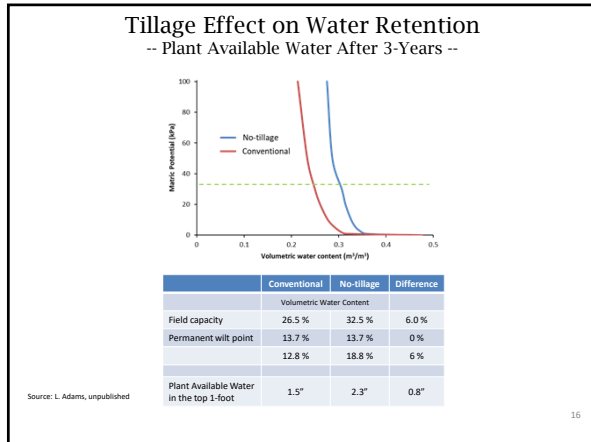
12











The Challenge

- Contrasting management systems and changes over time is possible within a specific location.
- Given the range in soils and climate within a country or region, developing thresholds for indicators is the main challenge.
- Other challenges include selecting "universal" soil indicators (e.g. properties to measure), establishing specific measurement procedures and sampling protocols, and develop robust linkages between soil health factors and water quality.
