SCIENCE OF SOIL HEALTH

What is it worth?
KEY POINTS

• Why soil health is important
• Examples of the impacts of poor soil
• Enhancing soil health
SOYBEAN PRODUCTION FIELD

Early August

Late August
CROP YIELD VARIATION
GOOD SOILS = GOOD YIELDS

Soybean yields across Iowa, Kentucky, and Nebraska

Y = 131.187 + 187.458X. \( r^2 = 0.72^{***} \)
MAIZE COUNTY YIELDS

\[ Y = 436.096 + 478.149X, \quad r^2 = 0.58^{***} \]
NCCPI ACROSS THE MIDWEST
IOWA COUNTY YIELDS

- **Floyd County**
- **Story County**
- **Washington County**
- **Cass County**

Each diagram shows the observed corn yields and the maximum corn yields over time for each county.
VARIATION IN YIELDS

The majority of the yield losses due to the weather are short-term stresses. 20% of the yield loss occurs 80% of the time due to water availability.
YIELD GAPS

Iowa Maize Story County

Year

Yield (kg ha⁻¹)
-2000
0
2000
4000
6000
8000
10000
12000
14000

Attainable Yield
Actual Yield
Yield Gap

Fraction of Attainable Yield
0.0 0.2 0.4 0.6 0.8 1.0
Cumulative Frequency
0.0
0.2
0.4
0.6
0.8
1.0

Cumulative Frequency vs. Fraction of Attainable Yield

Iowa Maize Story County
OBSERVATIONS

• Quality soil is critical to efficient crop production
• Variation in production is due to the short-term stresses
• These degraded soils have a large economic impact across the US in terms of yield and efficiency of input use
SOIL DEGRADATION SPIRAL

- Poor Land Management
- Aggregation Degradation
- Compaction & crusting
- Water & Wind Erosion
- Plant Growth
- Soil Biology
- Yield
- Reduced Soil Productivity

Yield

Reduced Soil Productivity

Soil Biology

Plant Growth

Water & Wind Erosion

Compaction & crusting

Aggregation Degradation

Poor Land Management
CROP INSURANCE

- Midwest Corn Crop Insurance
- Midwest Soybean Crop Insurance
- Midwest Wheat Crop Insurance
- Midwest Sweet Corn
SOIL AGGRADATION CLIMB

- Biological Activity
- Organic Matter Turnover
- Improved Nutrient Cycling
- Improved Soil Structure
- Improved Water Availability
- Efficiency
  - Yield
  - Profit
- Yield
- Profit
- Soils
- Yields
- Profit
BUILDING SOIL HEALTH

- Improving the soil requires a system with a stable environment for the soil biological system
- Have to couple soil biological system with a stable food source
The “living soil”, a biological system.

Earthworms, insects and rodents are “nature’s plow” and the most visible components of the “living soil” team. They work in tandem with other soil fauna, soil microorganisms and fungi to contribute to aeration and nutrient cycling as part of a “soil factory” team effort.
Crop residue benefits

Simple crop residue on the surface

Feeding the complex soil biology working hard for you below the surface.
“Passive protective blanket”

“Active protective blanket”
SOIL EXPERIMENT
CO$_2$ EVOLUTION

Growth Chamber 2014

Cumulative CO$_2$ (% generated)

Day of Year

Perfect Blend
UAN
Compost
Liquid Carbon +UAN
Biological Amendment + UAN
IMPACT OF TREATMENTS

Growth Chamber 2014

CO$_2$ Difference (Perfect Blend - UAN)

Day of Year
SOIL CHANGES

• Increasing soil biology increases the respiration rate
• Soil biology is critical to the formation and stabilization of soil aggregates
• Soil biology is linked to nutrient cycling in soil
LEAF CHLOROPHYLL 2012

Chisel-Plow Corn 2012

Leaf Chlorophyll Readings

Day of Year

Perfect Blend
SuperU

Leaf Chlorophyll Readings vs. Day of Year
CHLOROPHYLL SUMMATION INDEX

Corn 2009-2010

Summation of Chlorophyll Index Readings

Yield (kg ha\(^{-1}\))

Data points

Yield = 5019 + 2.78 CI

\(R^2 = 0.84\)
SOIL WATER USE RATES

Corn Water Use 2000

- Clarion Spring N (100 kg/ha)
- Webster Spring N (100 kg/ha)
- Clarion Fall N (200 kg/ha)
- Webster Fall N (200 kg/ha)
SOIL AGGRADATION CLIMB

Biological Activity

Organic Matter Turnover

Improved Nutrient Cycling

Improved Soil Structure

Improved Water Availability

Efficiency
Yield
Profit

Yield
Profit
SCIENCE OF SOIL HEALTH

- Assume we change soil health without considering that we need to use soil biology as the first step
- Recognize that biology is linked to all of attributes we consider as soil health