

Soil Health In Western ND

Principles, Problems, and
Solutions for the Future

Soil is an Essential Resource





Throughout History, Nations
Have Risen and Fallen by
Exhausting Soil Resources

Despite Their Best Knowledge, Past Societies Degraded Their Soils

Sumerians

Babylonians

Greeks

Romans

Maya

Degrading Practices

- Unsustainable Logging
- Excessive Tillage
- Leaving Ground Fallow
- Not Replenishing Nutrients

Beneficial Practices

- Crop Rotations
- Livestock Grazing
- Applying Manure



How Do We Protect This Valuable Resource for Posterity?

By focusing on soil health and soil function, producers can sustainably manage and improve soil health while still profitably growing crops and raising livestock

The diagram consists of three light green rounded rectangular boxes arranged in a triangle. The top box is labeled 'Biology'. The bottom-left box is labeled 'Chemistry'. The bottom-right box is labeled 'Physical Properties'. A double-headed arrow connects the 'Biology' box to the 'Chemistry' box. Another double-headed arrow connects the 'Biology' box to the 'Physical Properties' box. A third double-headed arrow connects the 'Chemistry' box to the 'Physical Properties' box. The background is a photograph of a green field under a blue sky with clouds.

Biology

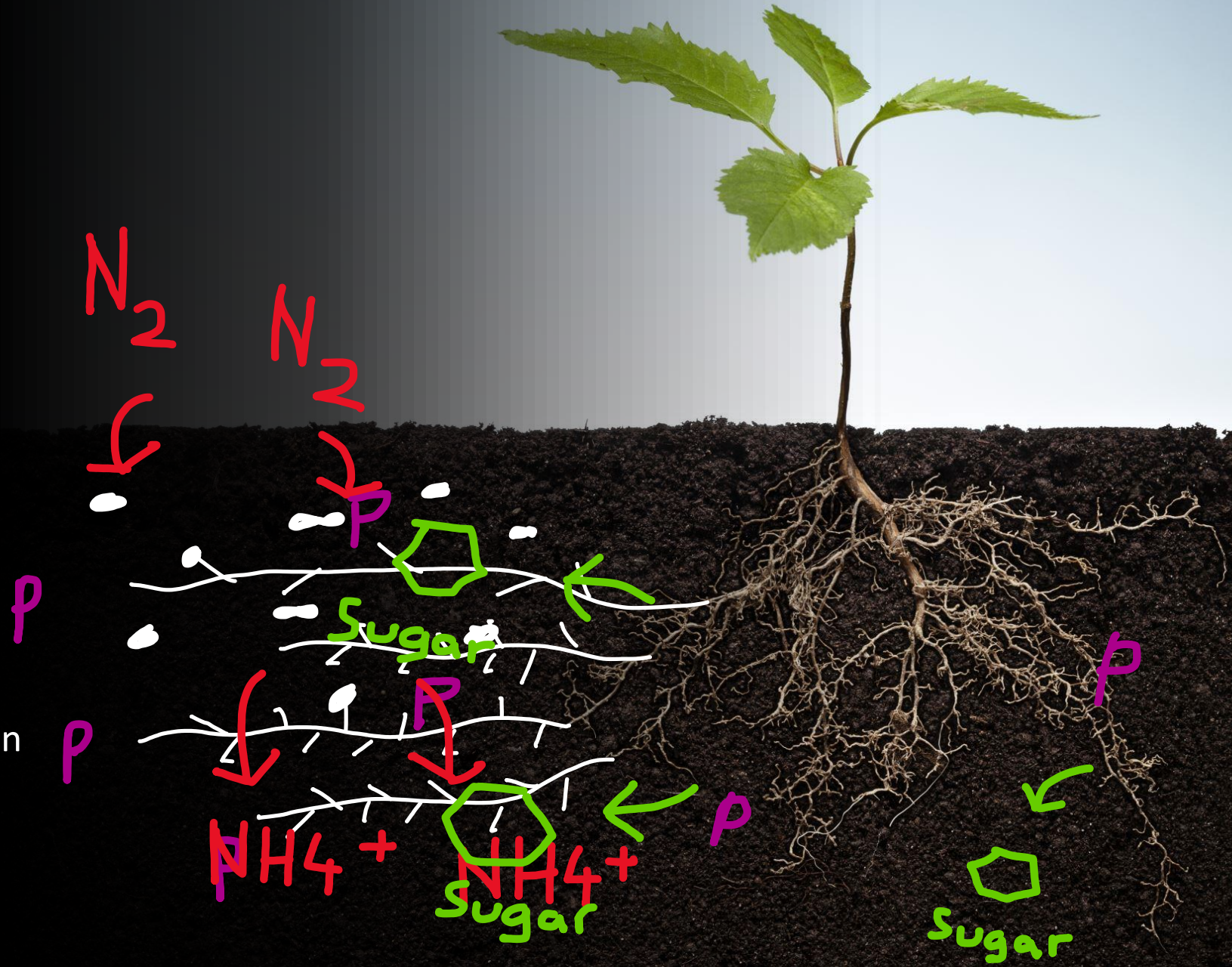
Chemistry

Physical
Properties

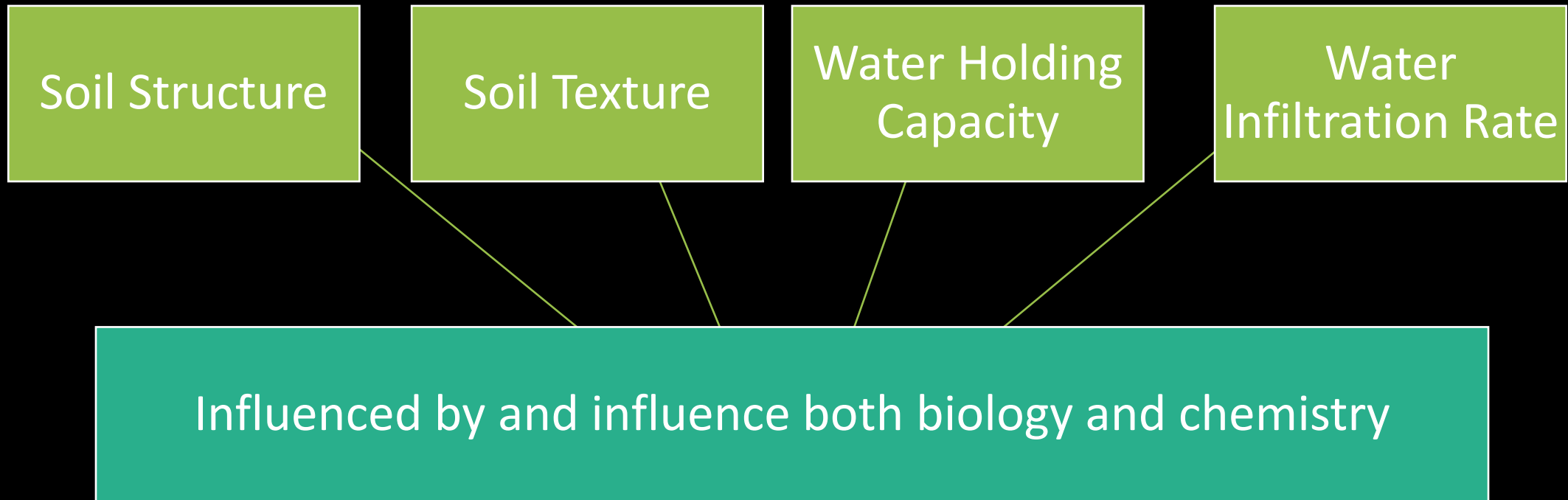
A properly
functioning
soil is a well-
balanced
system

Soil Biology

- Bacteria
- Fungi
- Nematodes
- Arthropods
- Plant Roots
- Earthworms
- Nutrient Cycling
- Organic Matter Decomposition



Soil Physical Properties



Soil Chemistry



Soil pH



Nutrient Levels



Nutrient
Availability



Biological
Reactions

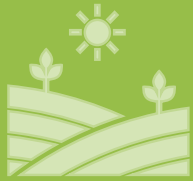


Organic Matter
Decomposition



Soil Salinity &
Sodicity

When all three aspects are in balance, soil performs the way it should



Be resilient to sudden shocks or changes such as drought or fire



Cycle Nutrients in the system without loss



Provide a home for soil organisms, plants, wildlife, and livestock

Soil Health Challenges

How can we better manage our soils to avoid degradation?



Soil Erosion

- Wind and water erosion remove fertile organic matter rich top-soil
- Conventional tillage systems allow bare soil to be impacted by wind and rain
- Poor crop rotations can exasperate erosion problems





New Technologies have emerged to help protect the soil from Erosion

Direct seeding allows crops to be seeded without the need for tillage to disrupt the soil ecosystem

Keeping the ground covered with residue reduces wind and water effects on the soil

Even with reduced tillage, stripper headers, and other technologies; there can still be erosion problems

Erosion Continues to be an Issue Today



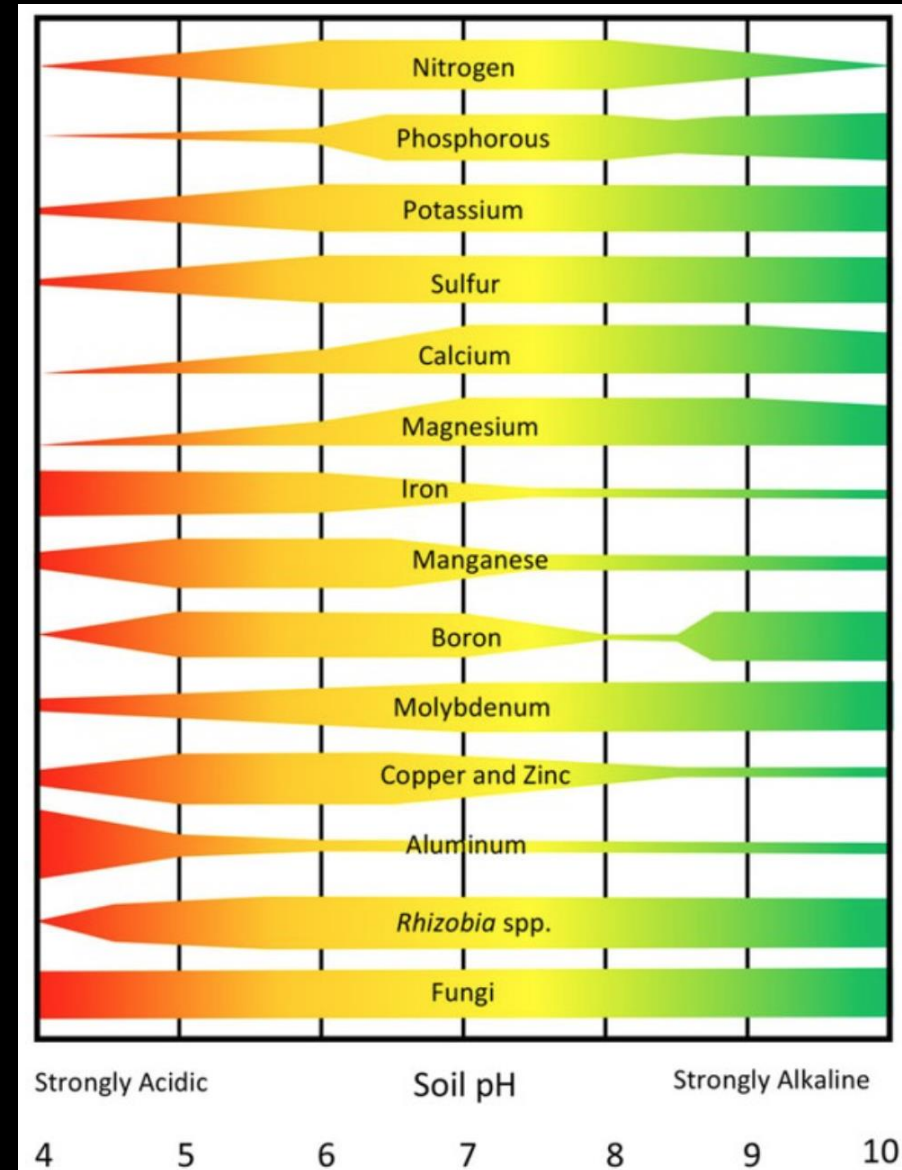
Managing Erosion

- Keeping the topsoil protected is of the utmost importance
- The best way to achieve this is by keeping the ground covered with residue or growing crops
- Certain crops are better at protecting the soil than others
 - Row crops have a large space between rows, allowing water to run
 - Legumes decompose very quickly, leaving little residue by spring
 - Small grains are seeded closer together and leave residue on the surface for a long time
- A robust crop rotation protects the soil surface, feeds the various soil microbes, and provides high profit margins



Low Soil pH

- North Dakota soils are naturally neutral or slightly alkaline
- Over 50 years of fertilizer application has acidified these soils
- 30 years of direct seeding and reduced tillage has concentrated the acidity in the top four inches



Soil Acidity Hurts Crop Establishment

Crop seeded into the acidic zone; young roots get damaged

Allows weeds to out-compete crops

Manganese & Aluminum Toxicity



Acidic Zone

Neutral Zone



Soil Acidity In Western North Dakota

- Reduced Crop Vigor
- Increased Weed Pressure
- Reduced Crop Competition
- Increased possibility of Erosion



Managing Low Soil pH

- Precision soil mapping
- Spread lime
- Use organic acid products to buffer acidity
- Use non-acidifying fertilizers
 - Gypsum and Nitrate
 - Split apply nitrogen to ensure maximum efficiency
 - Foliar feed in-crop
- In-furrow lime can protect young seedling establishment

Other Soil Health Management Challenges



Salinity and Sodicty Issues

Salt Issues are very common in semi-arid climates

- Saline soils are an excess of salts that get deposited from evaporating water
- Excess sodium (Sodic Soil) destroys soil structure and creates an impenetrable layer, not allowing water to drain and leach the salts down.
- Both are detrimental to soil health, not allowing the soil to function correctly.

Managing Saline Soil

- Precision Soil mapping
- Water Management
 - Plant perennial grasses, and remove them through haying or grazing
 - Tile Drainage will remove water from the soil
- Crop Selection
 - Barley and canola are salt tolerant crops
 - Legumes like dry beans and field pea are more susceptible
- Weed Control
 - Kochia and foxtail barley very common
 - No crop competition—perennial grass a good option

Managing Sodict Soil

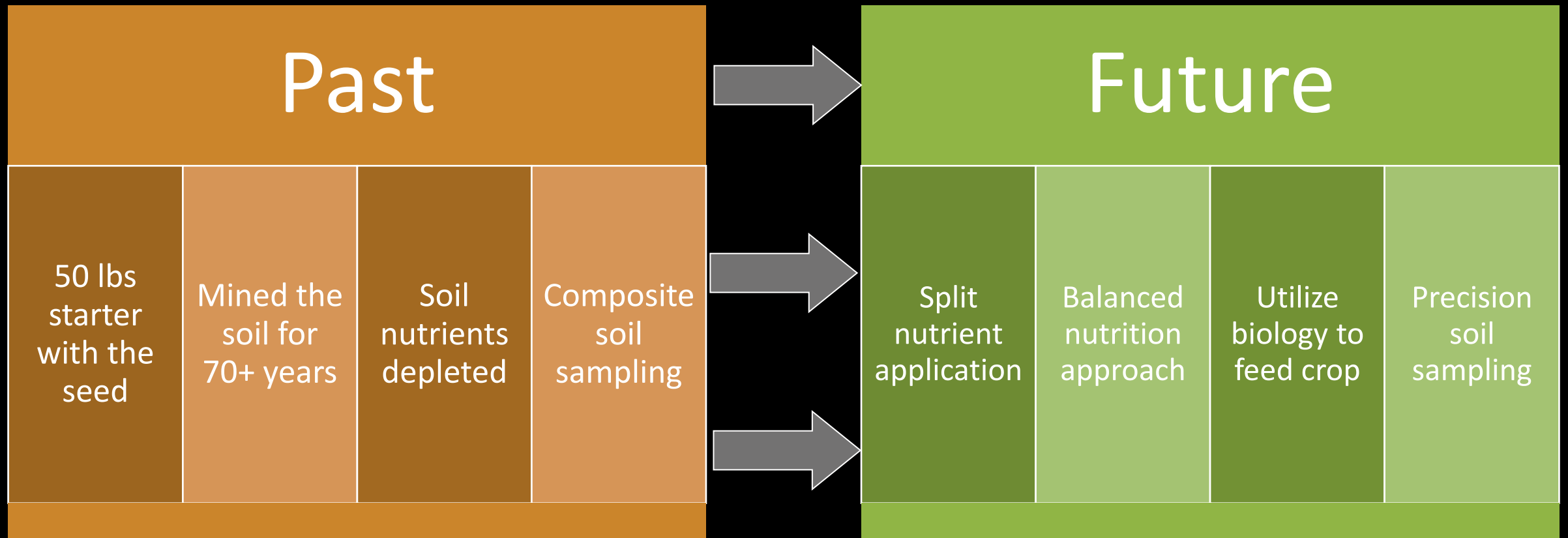
- Precision Soil Mapping
- Need to focus on leaching sodium down
 - Gypsum: Calcium Sulfate
 - Sulfate attaches to sodium and calcium replaces sodium in the soil
 - Managing water levels to keep the sodium deep in the soil
- Humic and fulvic acids can help remediate high sodium soils as well
 - Organic acids can improve soil structure
 - Chelate micro-nutrients normally unavailable in high sodium soils
 - Stimulate microbial activity
 - Can help to buffer out sodium effects on young growing plants

Traditional Fertility Practices Need to be Revised

- Higher Yields Require More Nutrients
- Nutrient Deficiencies are Growing
- New Fertility Strategies are Needed



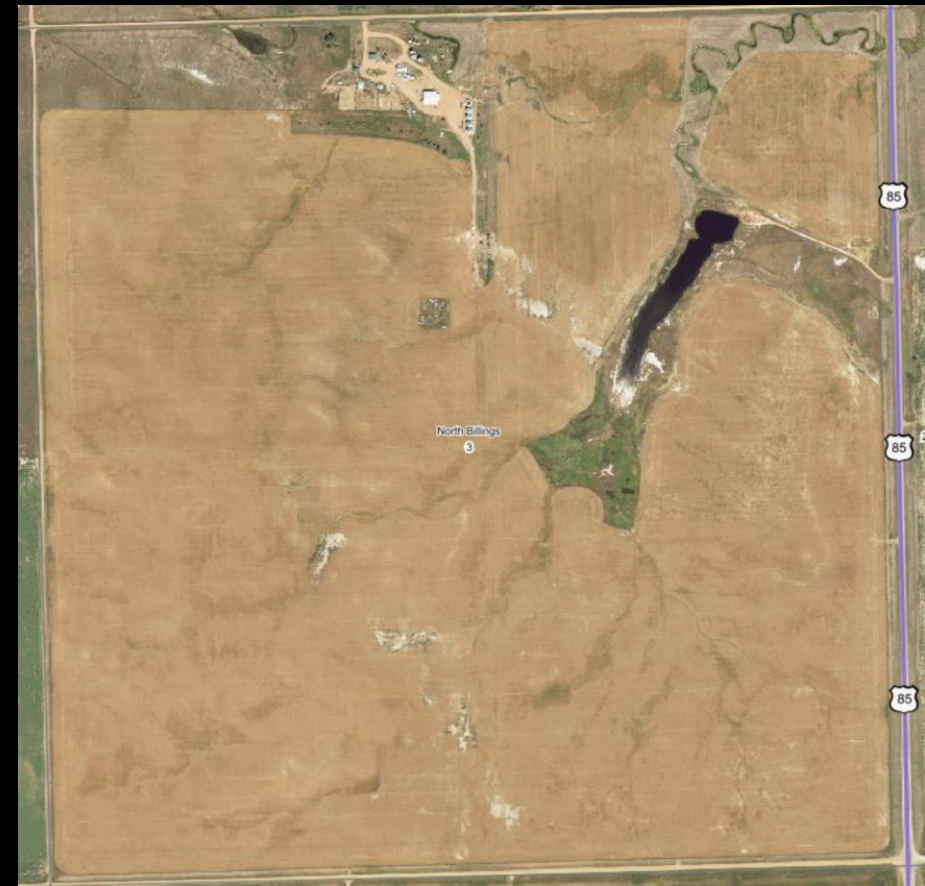
Better Nutrient Management



Soil Biology to help with plant diseases

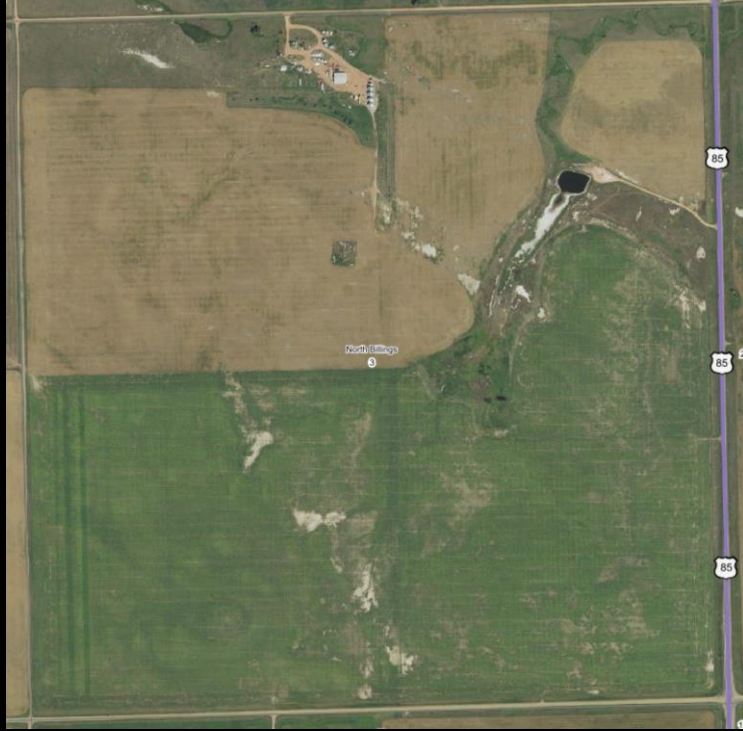
- The soil is a complex ecosystem
 - Both beneficial and pathogenic life forms
 - If beneficial microbes can outcompete pathogens, plant diseases can be minimized
- When the system is broken, then pathogens have an opportunity to attack growing crops
 - Need to have a healthy ecosystem
 - Many fungicides/nematicides are broad spectrum harming both good and bad species
- Try to only apply crop protection products when absolutely necessary
- New biological products fungicides or insecticides may focus on an individual pathogen--not harming beneficial organisms.

Every Field has a History that Affects Our Crops Even Today





2015



2020



2022

Layer: Sampling - Soil - 2018 - Hyground ...

Surface: Na %



Layer: Sampling - Soil - 2023 - HyGround ...

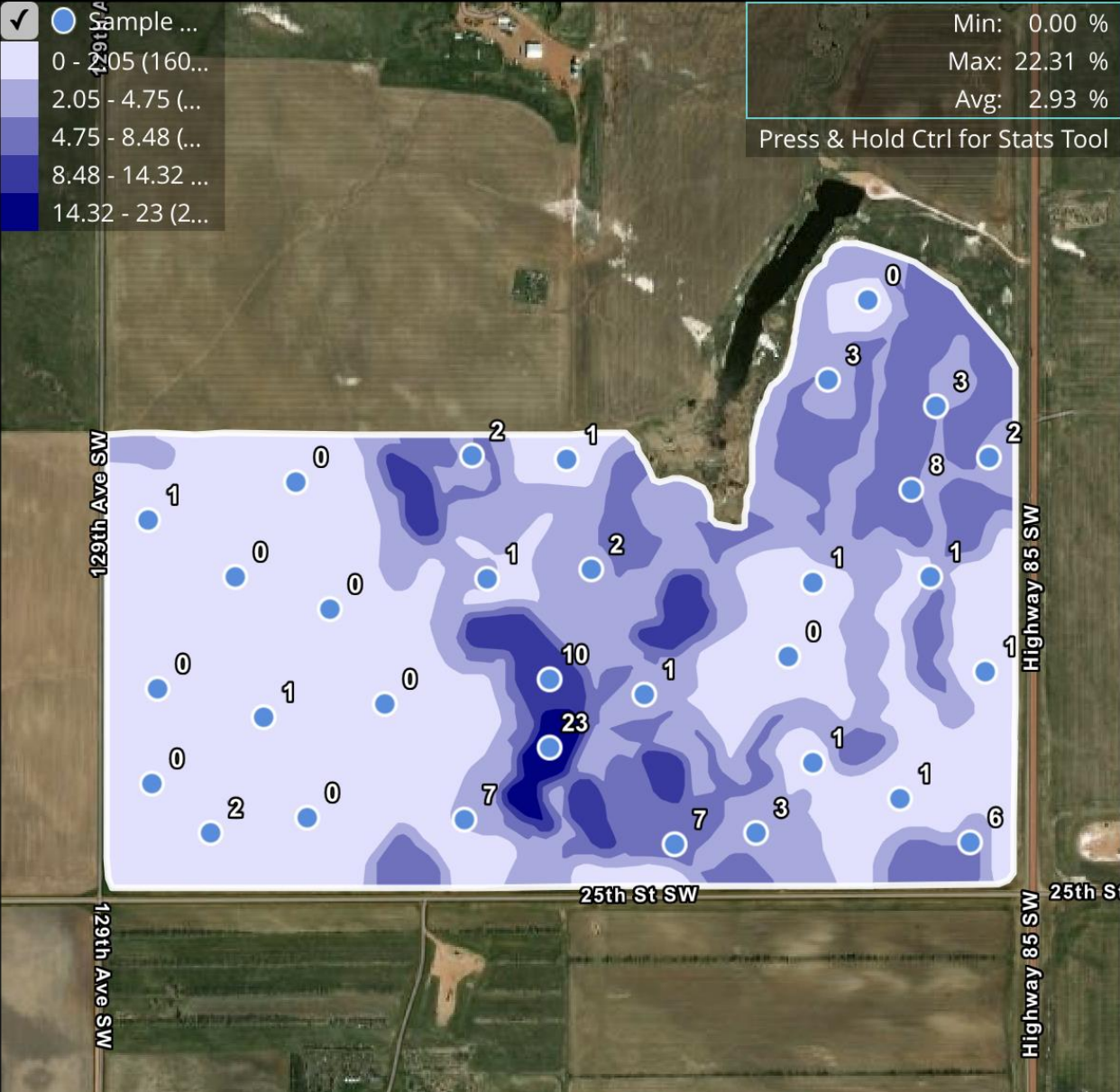
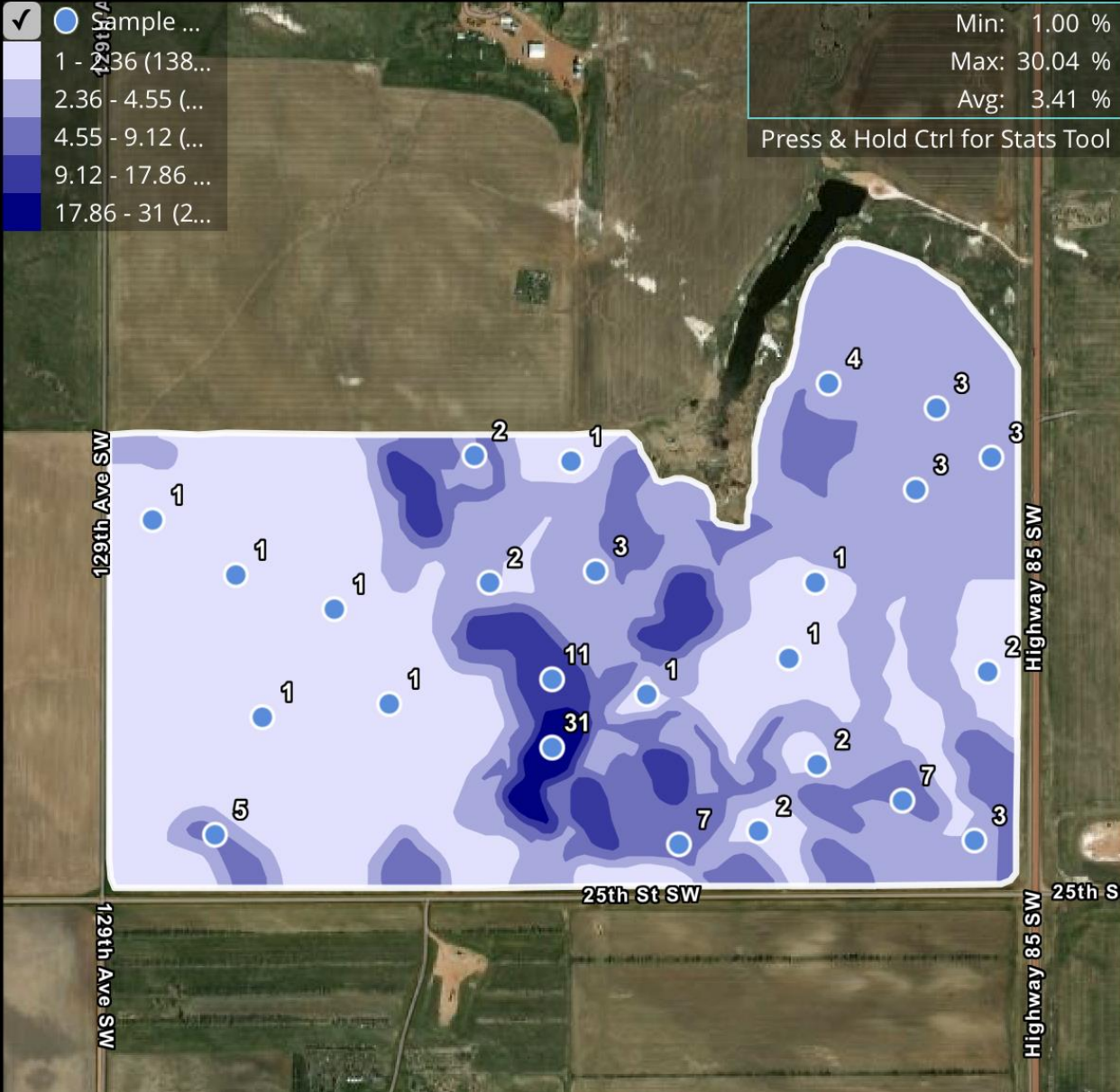
Surface: Na %

- ✓ Sample ...
- 1 - 236 (138...)
- 2.36 - 4.55 (...)
- 4.55 - 9.12 (...)
- 9.12 - 17.86 ...
- 17.86 - 31 (2...)

Min: 1.00 %
 Max: 30.04 %
 Avg: 3.41 %
 Press & Hold Ctrl for Stats Tool

- ✓ Sample ...
- 0 - 205 (160...)
- 2.05 - 4.75 (...)
- 4.75 - 8.48 (...)
- 8.48 - 14.32 ...
- 14.32 - 23 (2...)

Min: 0.00 %
 Max: 22.31 %
 Avg: 2.93 %
 Press & Hold Ctrl for Stats Tool



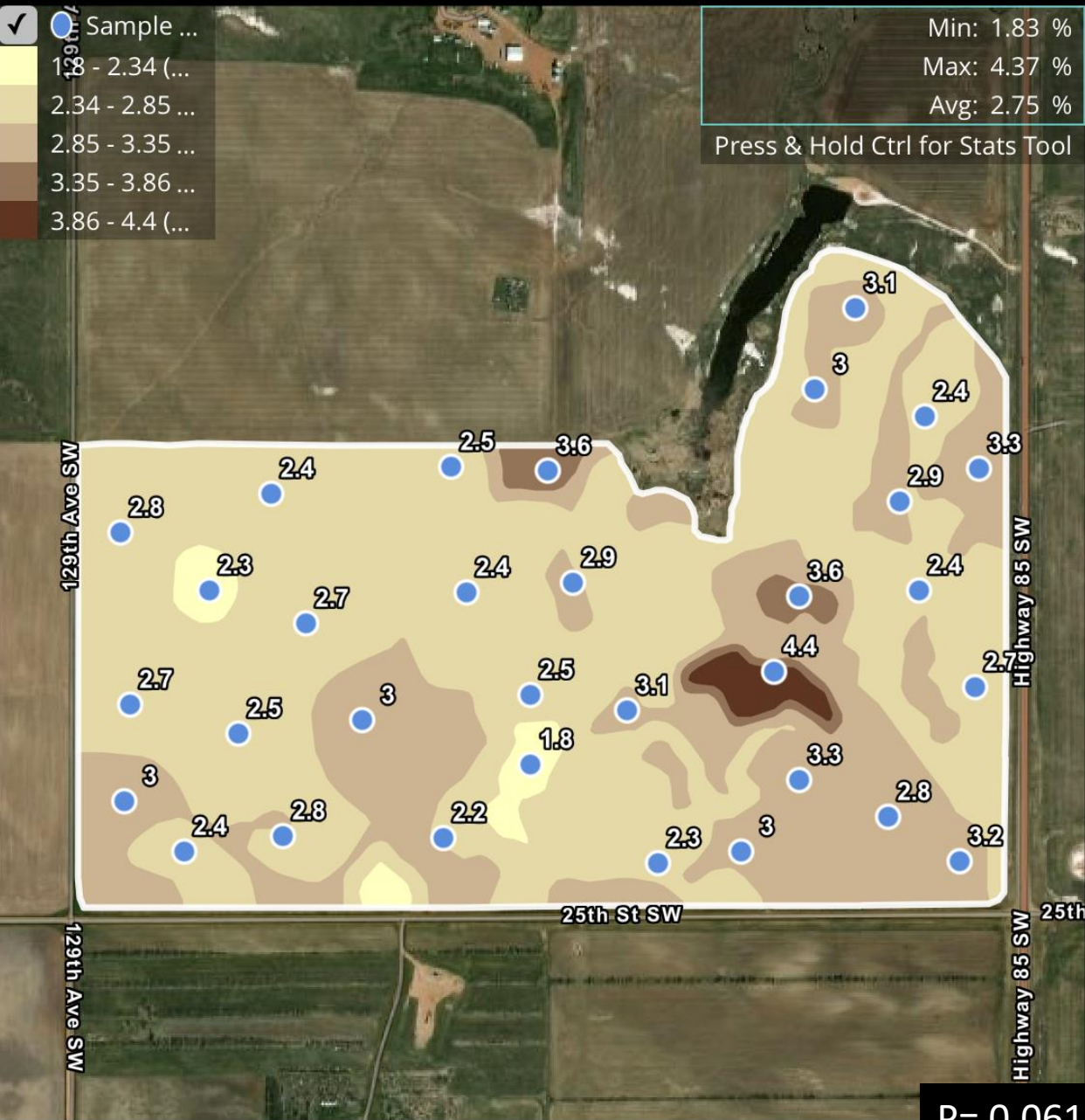
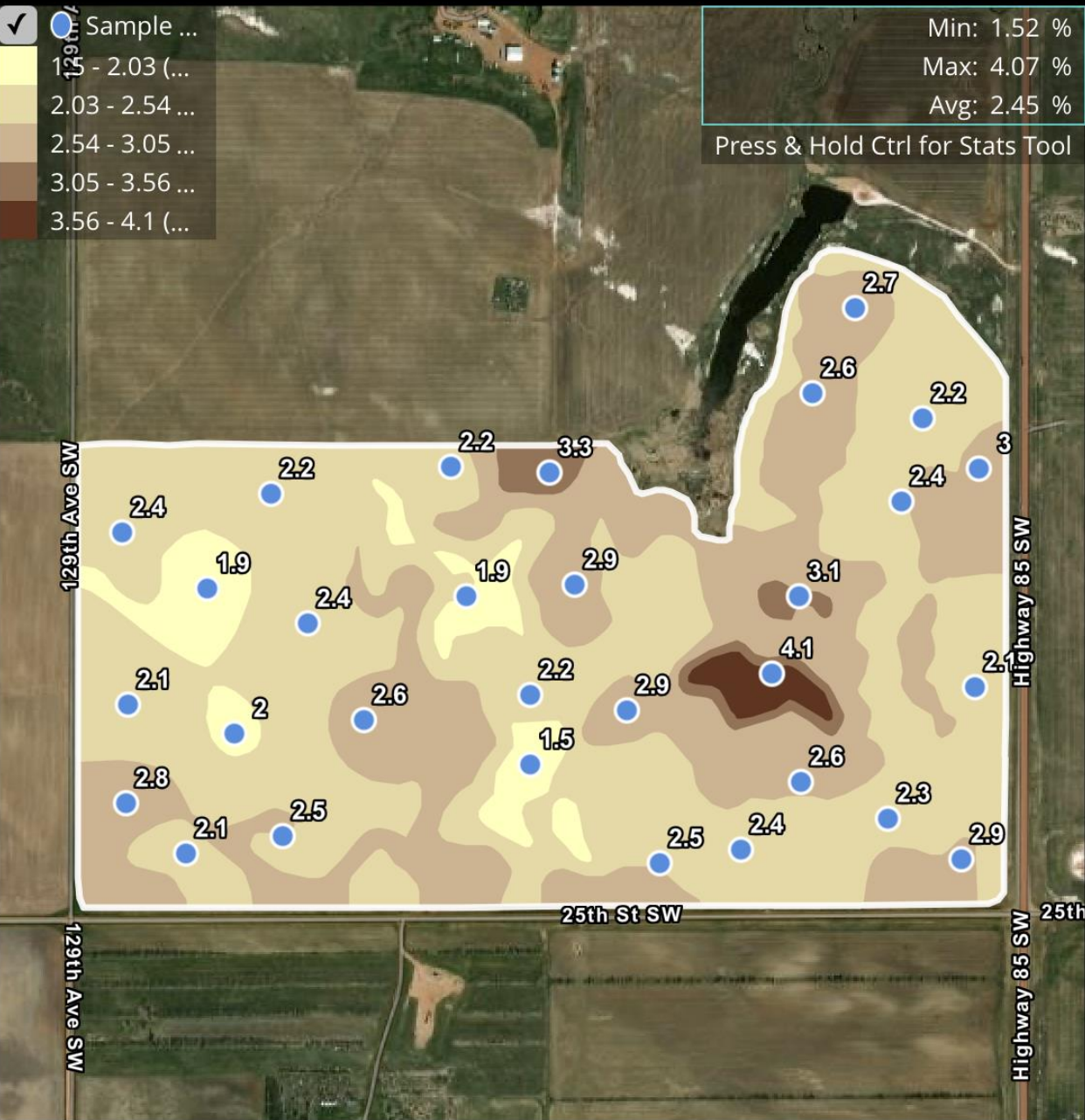


- Sample ...
- 1.52 - 2.03 (...)
- 2.03 - 2.54 ...
- 2.54 - 3.05 ...
- 3.05 - 3.56 ...
- 3.56 - 4.1 (...)

Min: 1.52 %
Max: 4.07 %
Avg: 2.45 %
Press & Hold Ctrl for Stats Tool

- Sample ...
- 1.83 - 2.34 (...)
- 2.34 - 2.85 ...
- 2.85 - 3.35 ...
- 3.35 - 3.86 ...
- 3.86 - 4.4 (...)

Min: 1.83 %
Max: 4.37 %
Avg: 2.75 %
Press & Hold Ctrl for Stats Tool



P = 0.061

Layer: Harvest - 2018 - Wheat - 8/12/18

Surface: Dry Yield (bu/ac) - Polygons

Layer: Harvest - 2022 - Wheat - 8/14/22

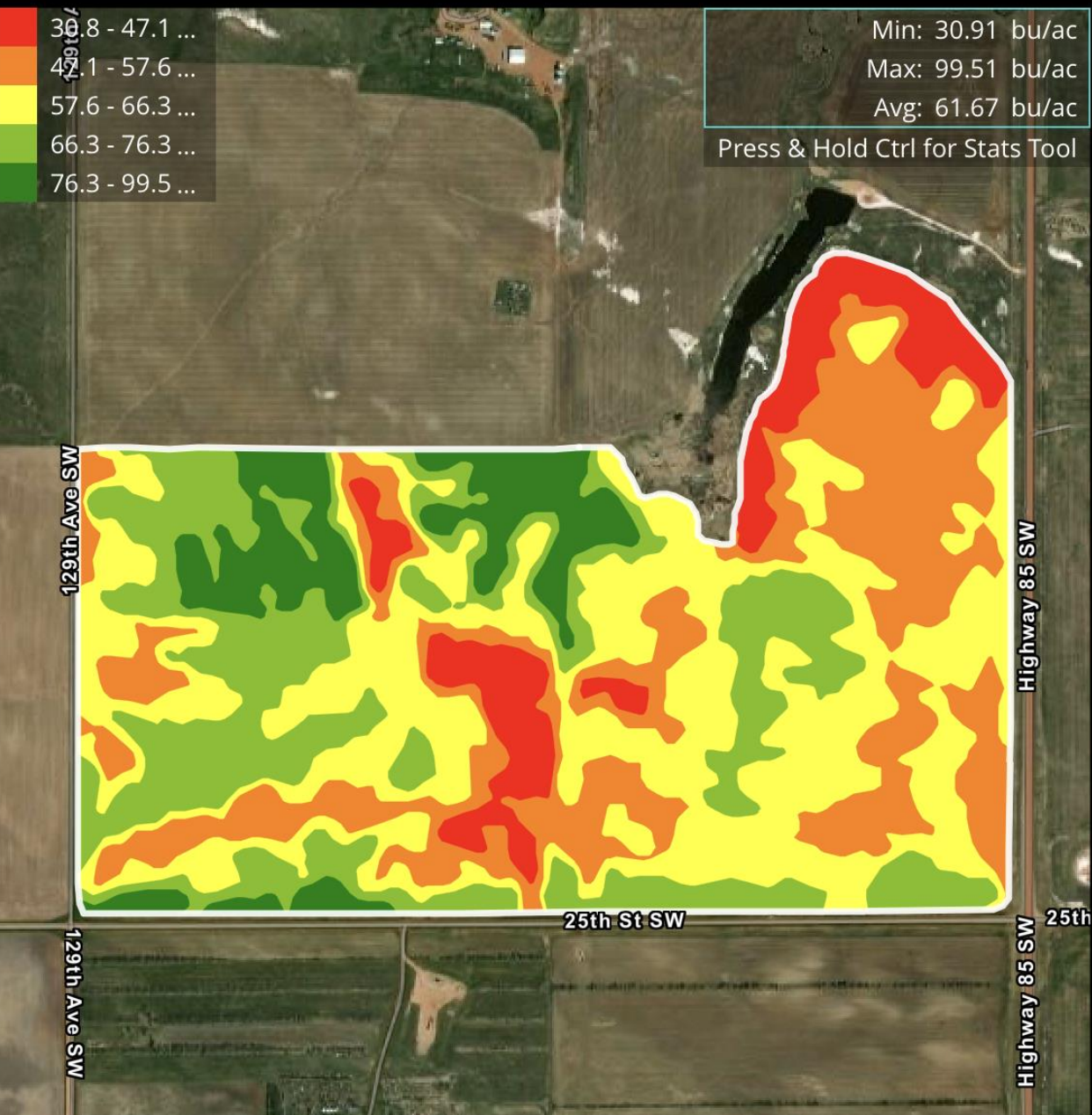
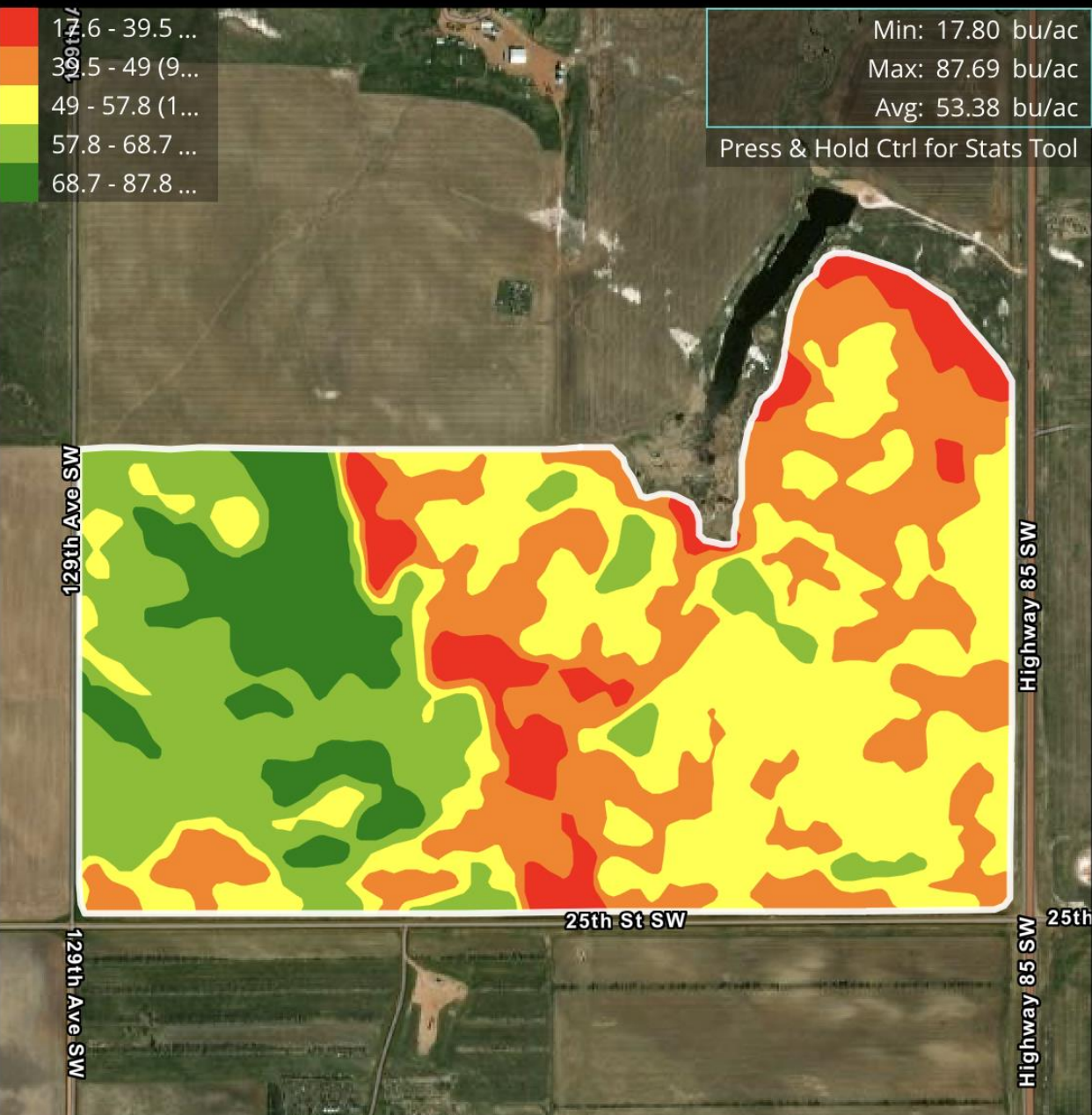
Surface: Dry Yield (bu/ac) - Polygons



Min: 17.80 bu/ac
 Max: 87.69 bu/ac
 Avg: 53.38 bu/ac
 Press & Hold Ctrl for Stats Tool



Min: 30.91 bu/ac
 Max: 99.51 bu/ac
 Avg: 61.67 bu/ac
 Press & Hold Ctrl for Stats Tool





Even though there are challenges, soil health and management practices have come a long way. Proactive management can make positive changes within a few years.



Soil Health Practices Need to be Realistic

- If a practice cannot be done effectively, efficiently, or economically it may not be a good fit for an operation
 - Cover crops are a great idea in theory
 - Equipment is expensive
- Small steps in the right direction
 - Try a new crop on one field
 - Soil Sampling
 - Try Variable Rate Fertilizer
 - Rent new equipment for a year to try it out





Final Thoughts

- Owners make better farmers
 - Willing to invest to improve soil
 - Find ways to get landowners and growers to work together
 - Long lease contracts, cost sharing
 - Excessive weed issues can be a sign of poor soil health
 - Grassy weeds usually are a sign of acidic soil
 - Kochia is usually a sign of saline or sodic soil
- 