Soil Amendments on Northern Plains

- Many soils in Northern Plains have high pH (>7.3) and high salinity (salts)
- Farmers know these issues may reduce yields and are always looking for the "easy button" to "fix" these issues.
- Some people tell farmers a couple hundred pounds of soil amendments can "fix" these issues
- Elemental sulfur and gypsum are often mentioned in these claims.

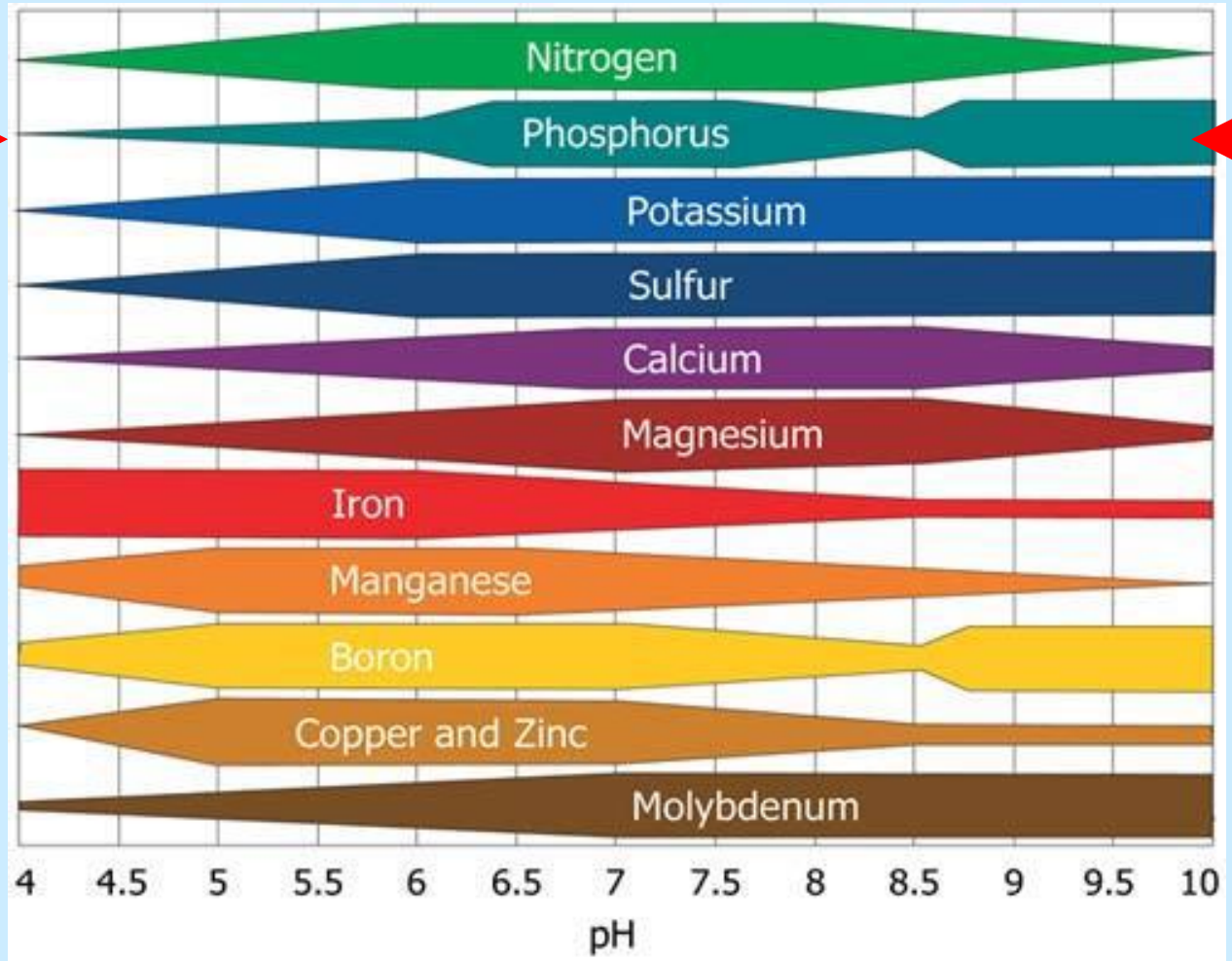

easy

Soil Amendments to reduce Soil pH

- If you could lower a soil pH from 8.0 to about 7.0 and keep it there, the availability of nutrients, like phosphorus, will increase.
- Reducing pH (along with carbonates) may also reduce IDC in soybeans.
- Will a couple hundred pounds of elemental sulfur or gypsum lower soil pH?

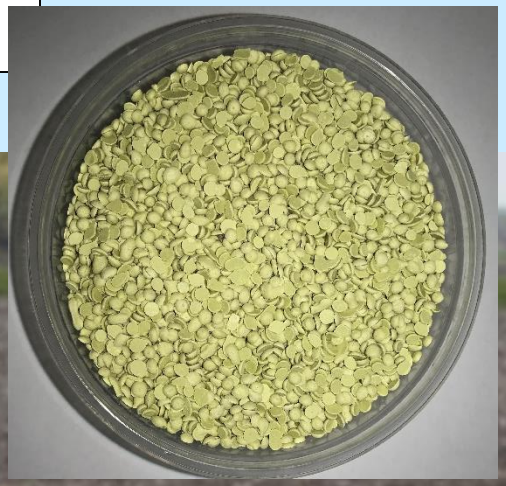
Soil pH – Availability of Nutrients

Lowering soil pH may increase nutrient availability. (Soils with free calcium carbonate have pH around 7.5 - 8.2.)



AGVISE – Soil Amendment Project 2005-2017

- *10,000 lb/a Elemental Sulfur*



Can 10,000 lb Elemental S Lower Soil pH?

H^+ H^+

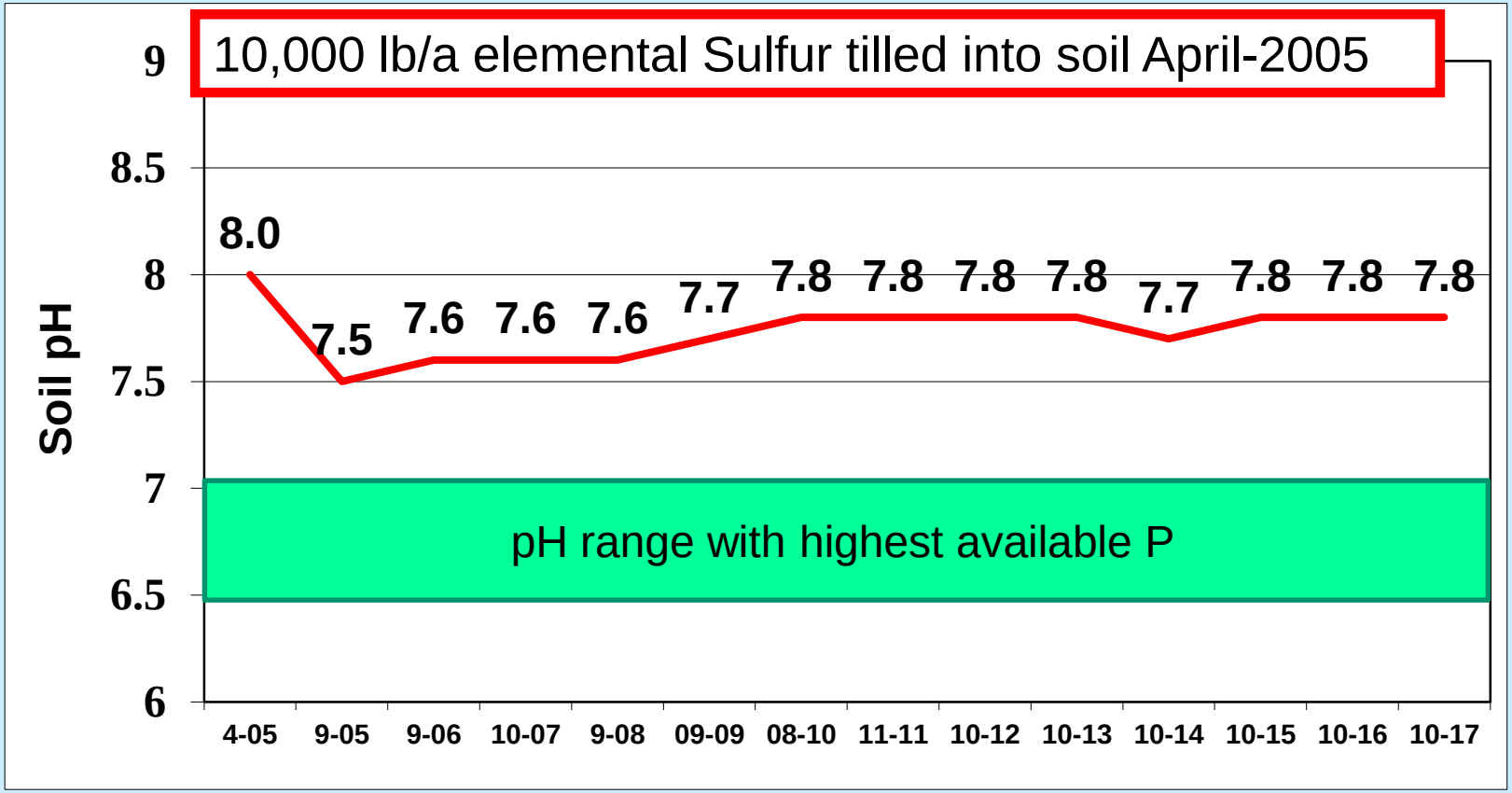
$$2S + 3O_2 + 2H_2O \longrightarrow 2H_2SO_4$$

Sulfur + Oxygen + Water ⟶ Sulfuric Acid

Elemental sulfur must be mixed with moist, warm aerated soil with bacteria (*Thiobacillus*) for this reaction to occur. The hydrogen (H^+) from the sulfuric acid lowers pH. If soil contains carbonates (pH higher than 7.3), it will require very high rates of sulfur to change pH permanently.

Does Elemental Sulfur Lower Soil pH?

YES, but rate must be high and change may not be permanent



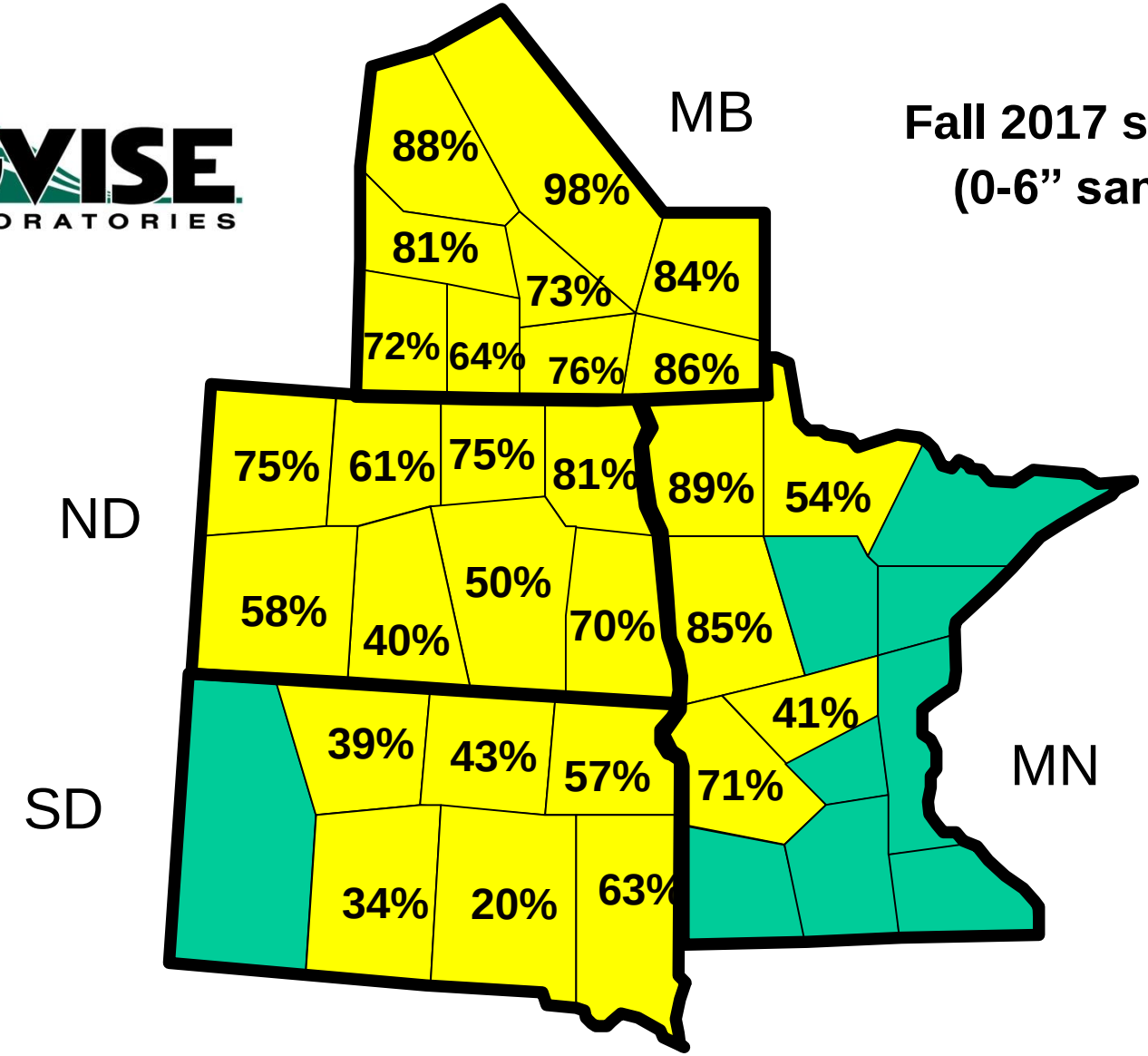
Soil (CCE) Carbonate level is 1.5%, loam soil texture

% Soil samples with carbonate greater than 1.0%

For most soils in this region, it is impossible to lower pH because carbonate will neutralize acid.

AGVISE LABORATORIES

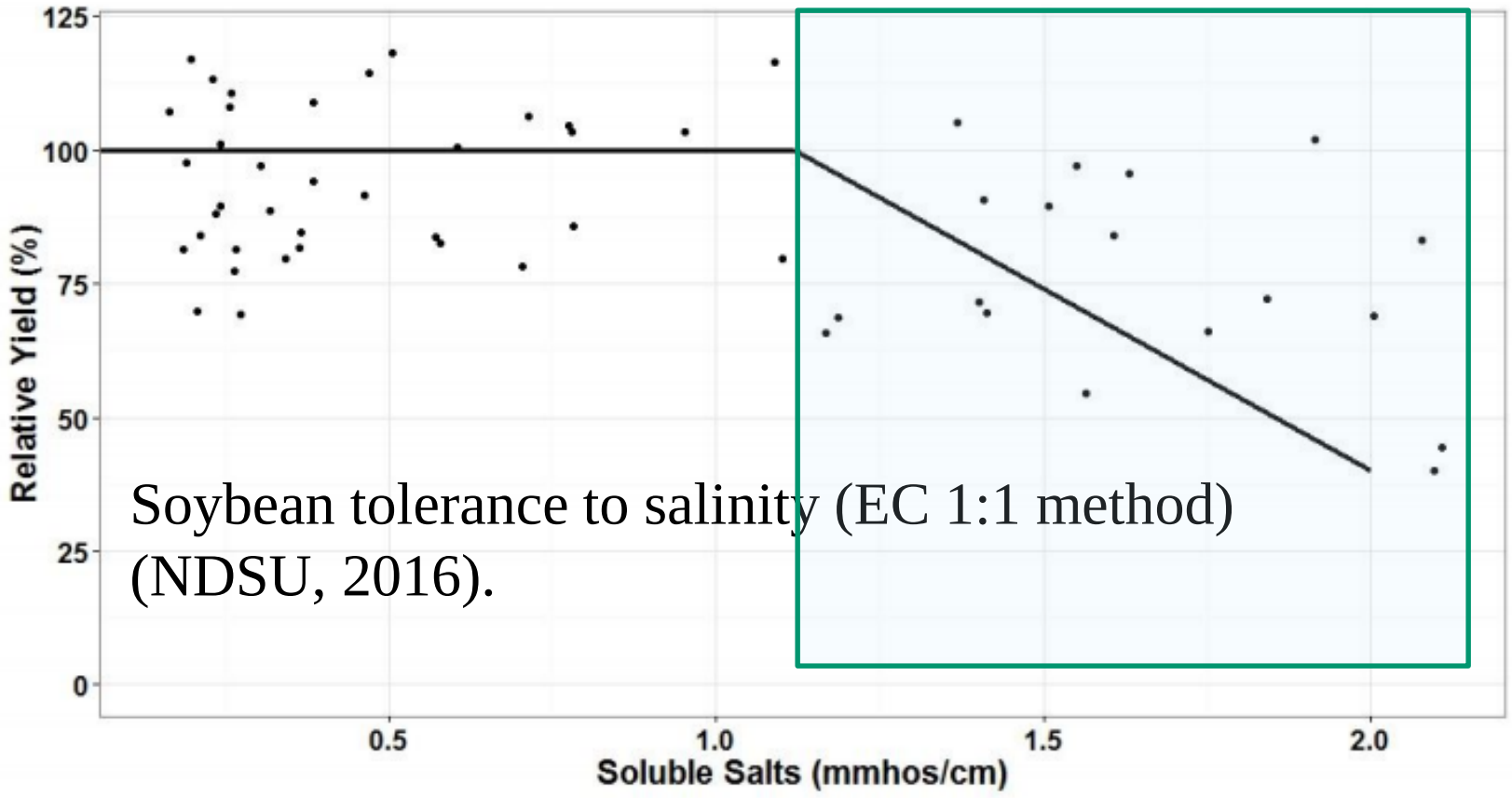
Fall 2017 samples (0-6” samples)



Effect of 10,000 lb Elemental Sulfur on Soil pH

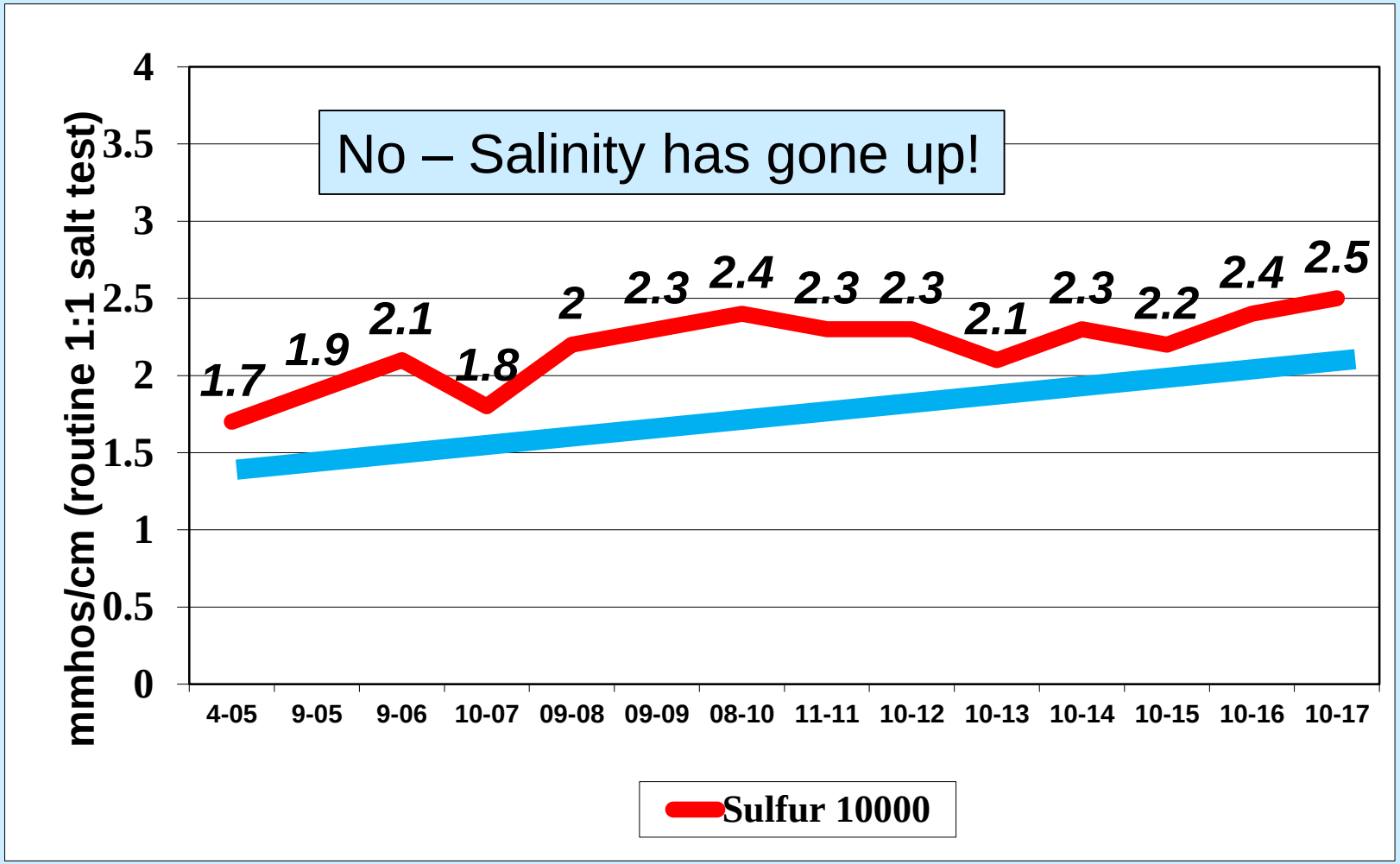
- Reduced by 0.5 pH unit in first year, then increased to near original pH.
- Calcium carbonate in soil was not completely neutralized by elemental sulfur, so pH change was not permanent and went back up.
- Since 10,000 lb of elemental S was not enough to lower pH in 12 years, maybe we will increase rate to 100,000 lb elemental S next time!
- Couple hundred pounds won't do it!!!

Farmers would like to lower Salinity too! Can Elemental Sulfur do that? (Soybeans would benefit)



Soybean tolerance to salinity (EC 1:1 method) (NDSU, 2016).

Does 10,000 lb/a Elemental Sulfur Reduce Soluble Salts?



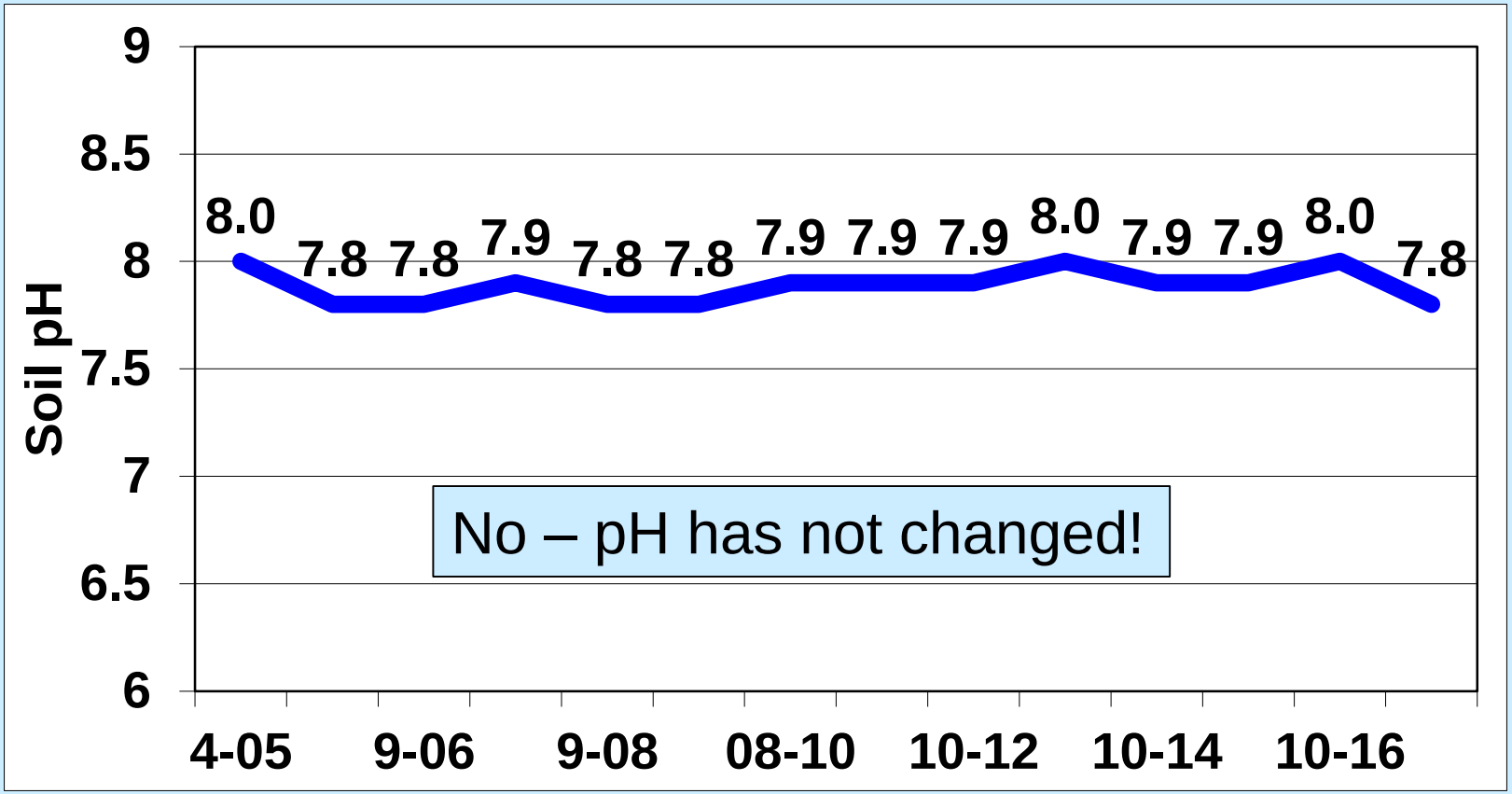
Effect of 10,000 lb Elemental Sulfur on Salinity

- Salinity increased over time.
- Elemental sulfur reacted with calcium carbonate ($CaCO_3$) in soil to form gypsum ($CaSO_4$), which caused the salinity to increase to about 2.2 mmhos/cm (conductivity of saturated gypsum solution).
- Elemental S did not lower salinity in 12 years. Salinity actually increased as we expected.
- Elemental S will not reduce salinity (salts).

AGVISE – Soil Amendment Project 2005-2017

- *5,000 Gypsum*

Does 5000 lb/a Gypsum ($CaSO_4$) Decrease Soil pH?



Loam Soil texture, Carbonate level (CCE) = 1.5%, poorly drained

5000 lb/a Gypsum tilled into top 6” of soil - April 2005

Gypsum slowly dissolves No chemical reaction to change pH (No H^+)

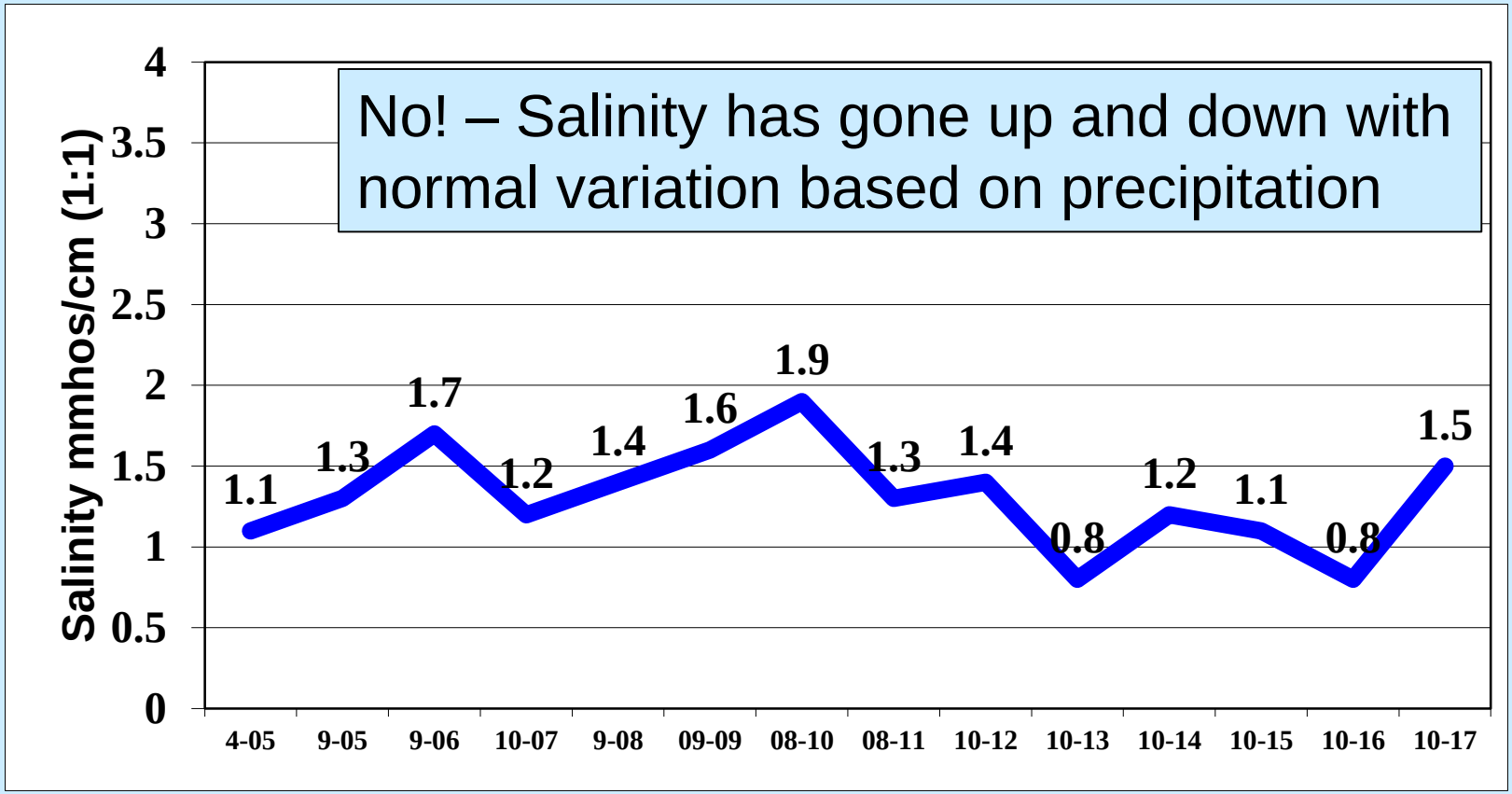
$$CaSO_4 \cdot 2H_2O \rightarrow Ca^{2+} + SO_4^{2-} + 2H_2O$$

Gypsum → calcium + sulfate + water

No H^+ produced when gypsum slowly dissociates into calcium and sulfate ions in the soil solution.

If no hydrogen (acid) is created, the soil pH should not change!

Can Gypsum Lower Soluble Salts?



5000 lb/a Gypsum tilled into soil 4-26-2005

Effect of 5,000 lb Gypsum on Salinity

- Salinity varied over time corresponding to wet and dry years, showing the role of water movement on changing salinity level from year to year.
- Gypsum is a slowly soluble salt that dissolves in the soil solution. It dissociates into ions which actually increase soil salinity.
- Gypsum did not lower the salinity in 12 years.
- Gypsum is not a useful amendment for lowering soil salinity. Yet, it can be useful for soils with high sodium.

What are viable alternatives? Soil Amendments can't economically lower soil pH?

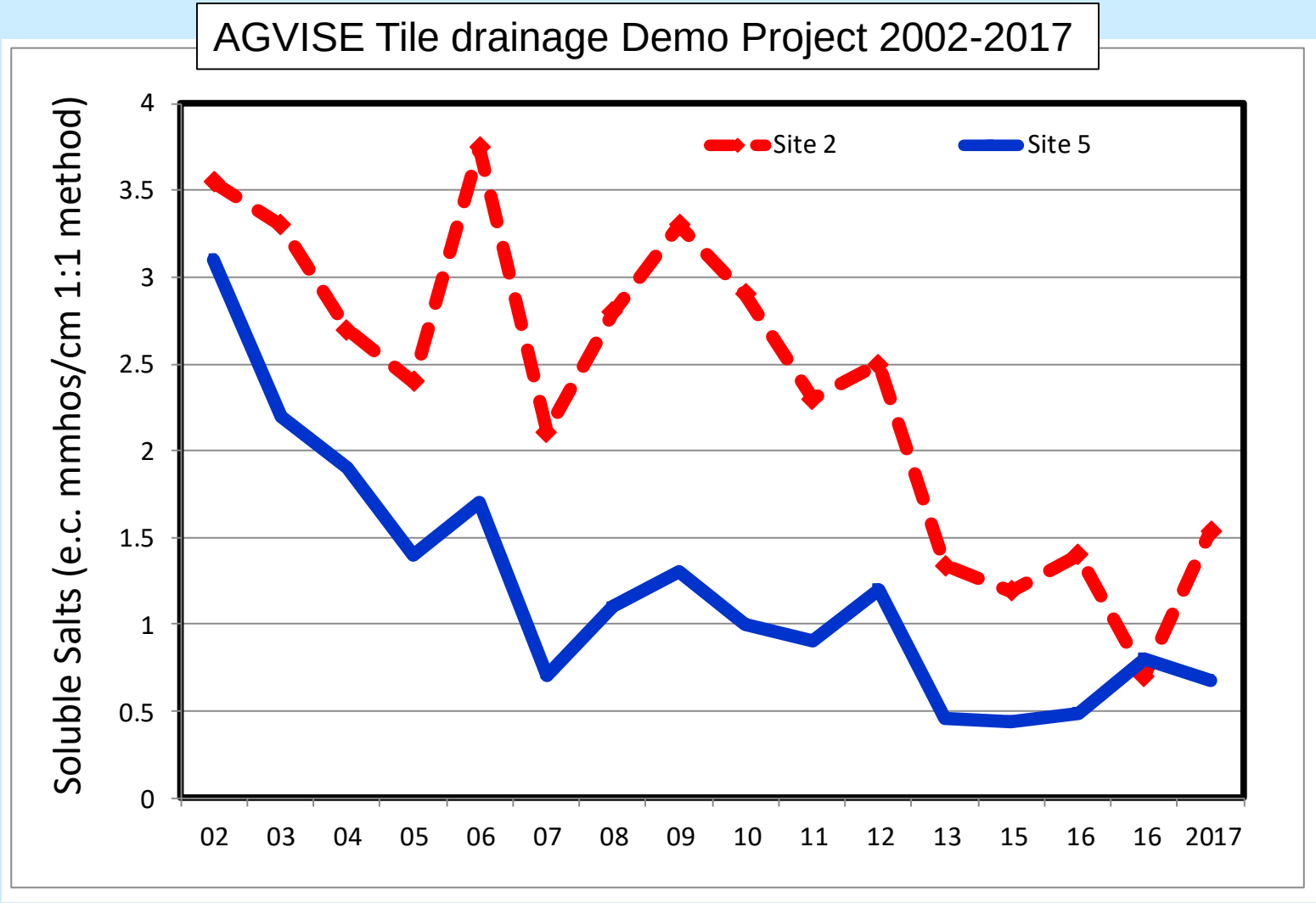
- Apply more P fertilizer in bands
- Apply higher rates of P fertilizer
- Building P soil test levels is not easy in high pH soils, but it is much less expensive than trying to reduce the soil pH
- For IDC – (high pH soils with carbonates)
  - IDC varieties, wide rows, Fe-EDDHA

What are viable alternatives? Soil Amendments can't economically reduce salinity?

- Include more high water use crops in rotation to lower the water table
  - Corn, sunflower, alfalfa
- Keep something growing all season
  - Cover crops, perennial grasses
- Improve surface drainage
- Tile drainage

Tile drainage "can" lower salinity

(along with crop rotations that use much water)



Soil amendment "Myths" are here to stay!

Human nature is to look for the "easy button"

Lowering soil pH and salinity will never be easy or inexpensive!

Beware promises of products saying this will be easy!

Demo project 2018
Liming very acid no-till fields

- Cooperators and sites needed
- Long-term no-till (10 plus years)
- Low pH topsoil (less than 6.0)
- Low pH subsoil (less than 6.5)

We will be applying lime and tracking effect of lime through the topsoil over time. Incremental sampling 0-2”, 2-4”, 4-6” testing pH and nutrients

Thank You for your business

CEU sign out!
Ideas for topics and Speakers
Travel Safe!