MANAGING ACIDIC SOILS:
HERBICIDE AND FERTILITY STRATEGIES FOR FARM AND GARDEN

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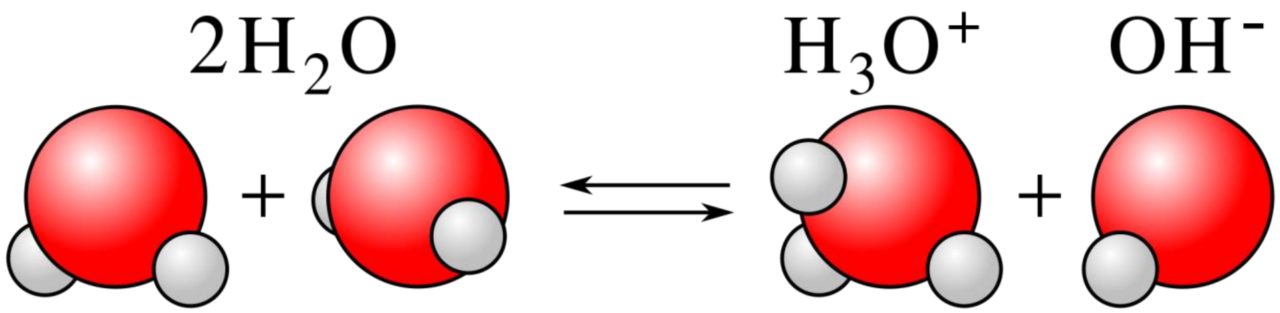
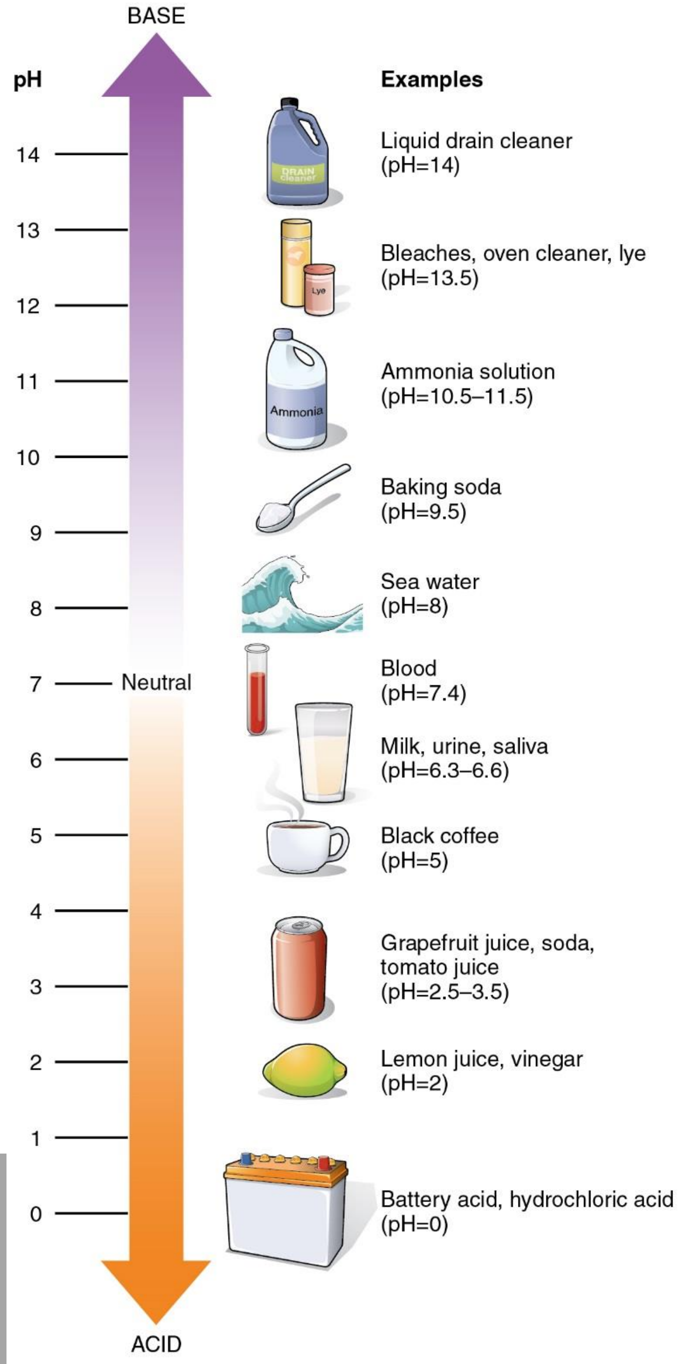
UI – EXTENSION

University of Idaho Extension

SOIL ACIDITY

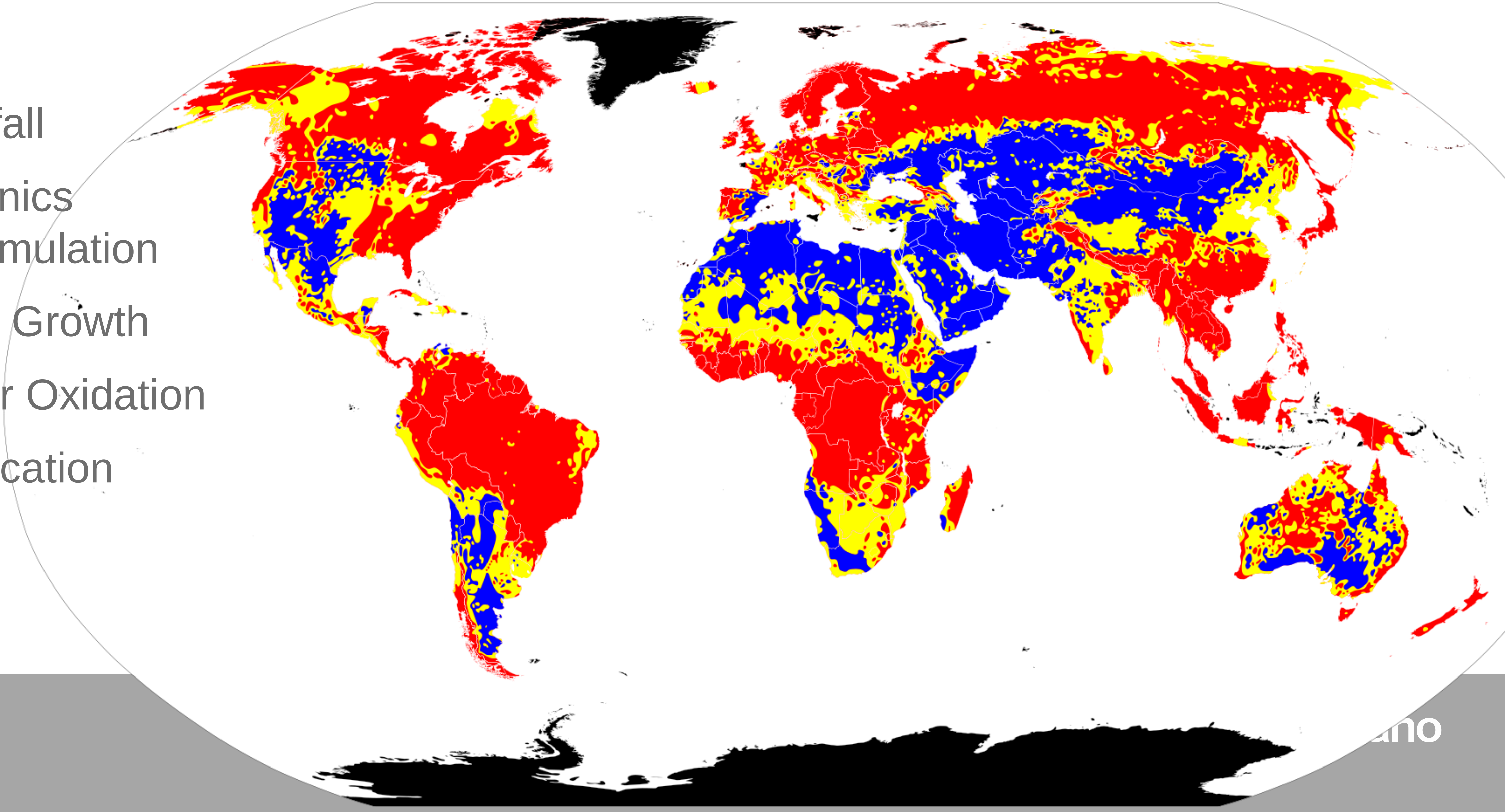
WHAT IS ACIDITY?

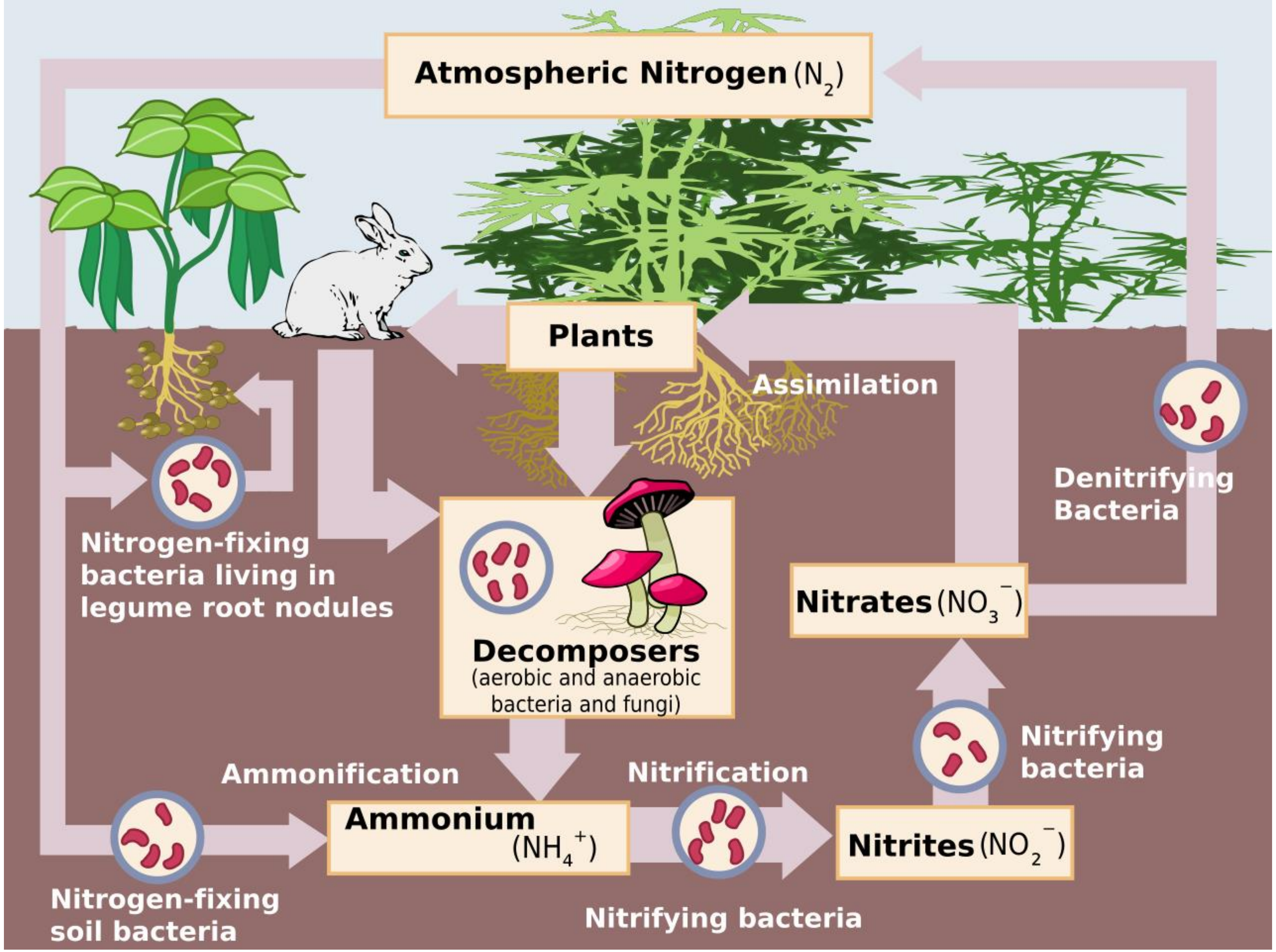




NATURALLY ACIDIFYING PROCESSES

- Rainfall
- Organics Accumulation
- Plant Growth
- Sulfur Oxidation
- Nitrification

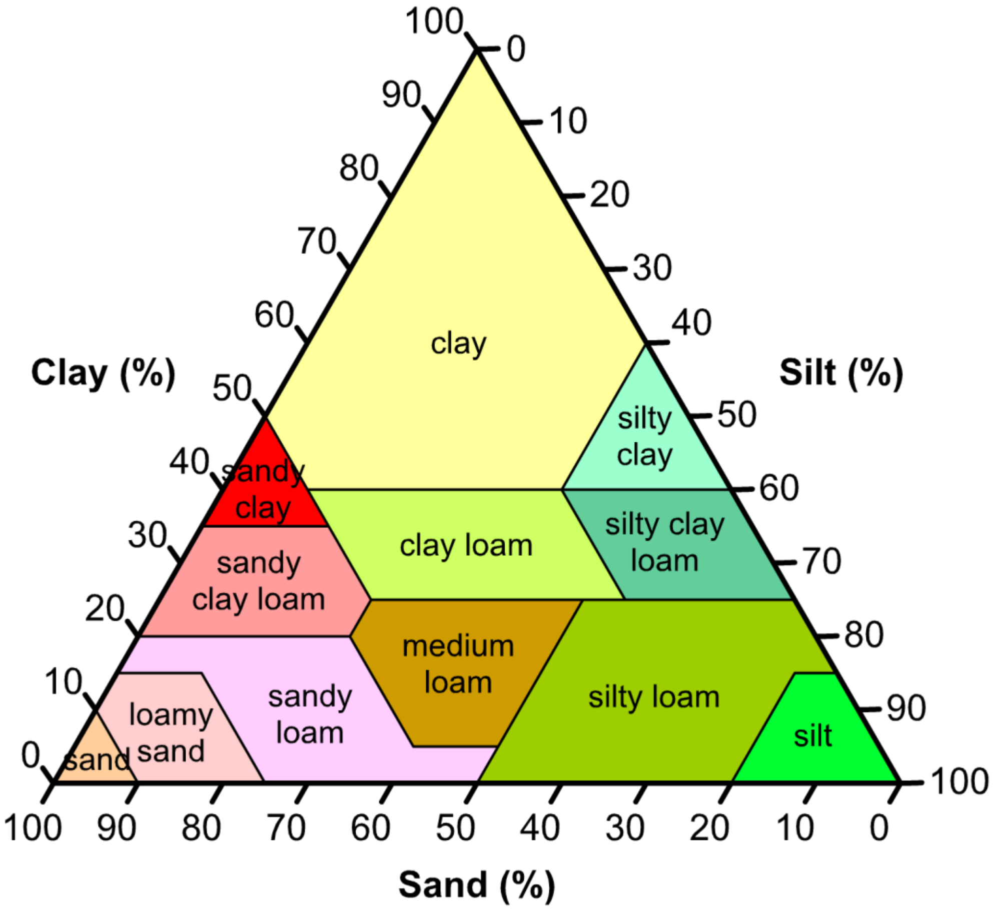


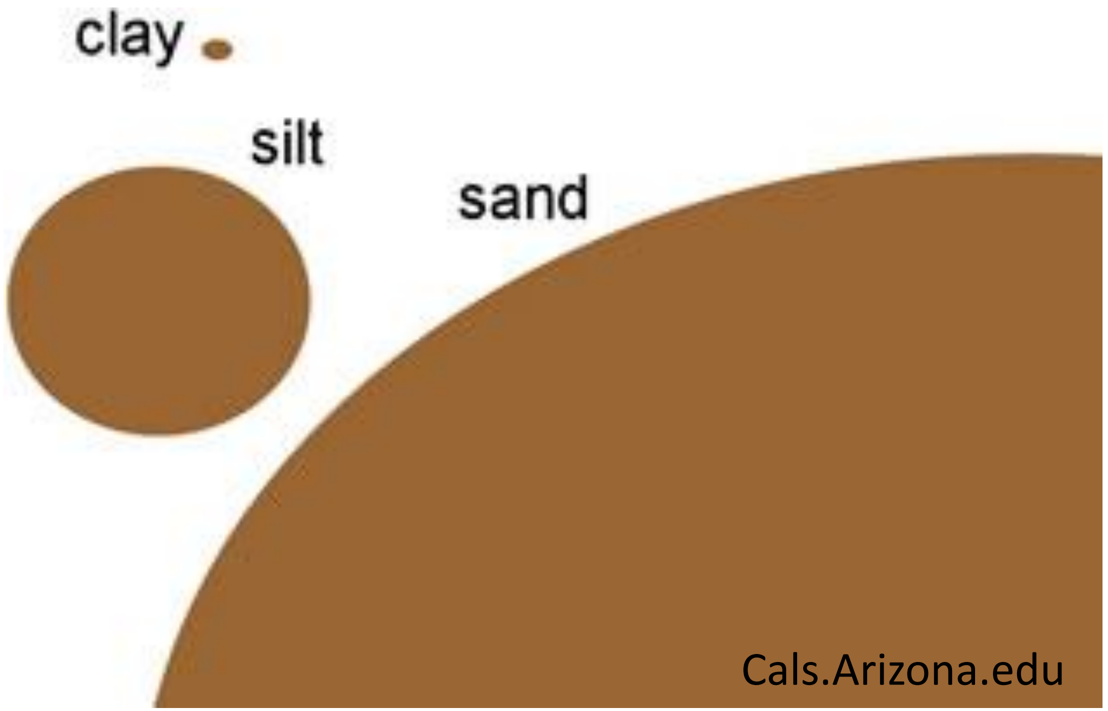


Atmospheric Nitrogen (N_2)
Plants
Assimilation
Denitrifying Bacteria
Nitrogen-fixing bacteria living in legume root nodules
Decomposers
(aerobic and anaerobic bacteria and fungi)
Nitrates (NO_3^-)
Nitrifying bacteria
Ammonification
Nitrification
Ammonium (NH_4^+)
Nitrites (NO_2^-)
Nitrogen-fixing soil bacteria
Nitrifying bacteria

THAT'S NEAT. HOW DOES IT AFFECT MY FARM OR GARDEN?

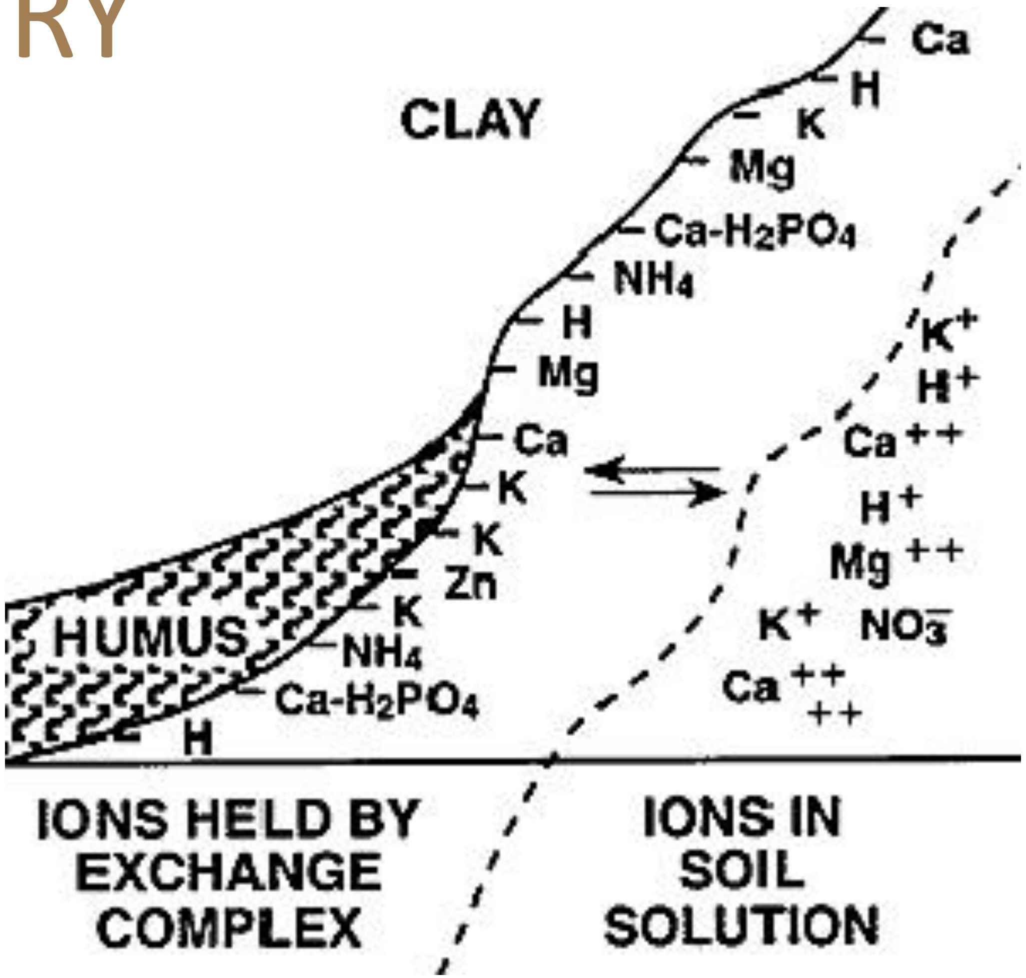
SOILS 101 – SOIL STRUCTURE





SOILS 101 – SOIL CHEMISTRY

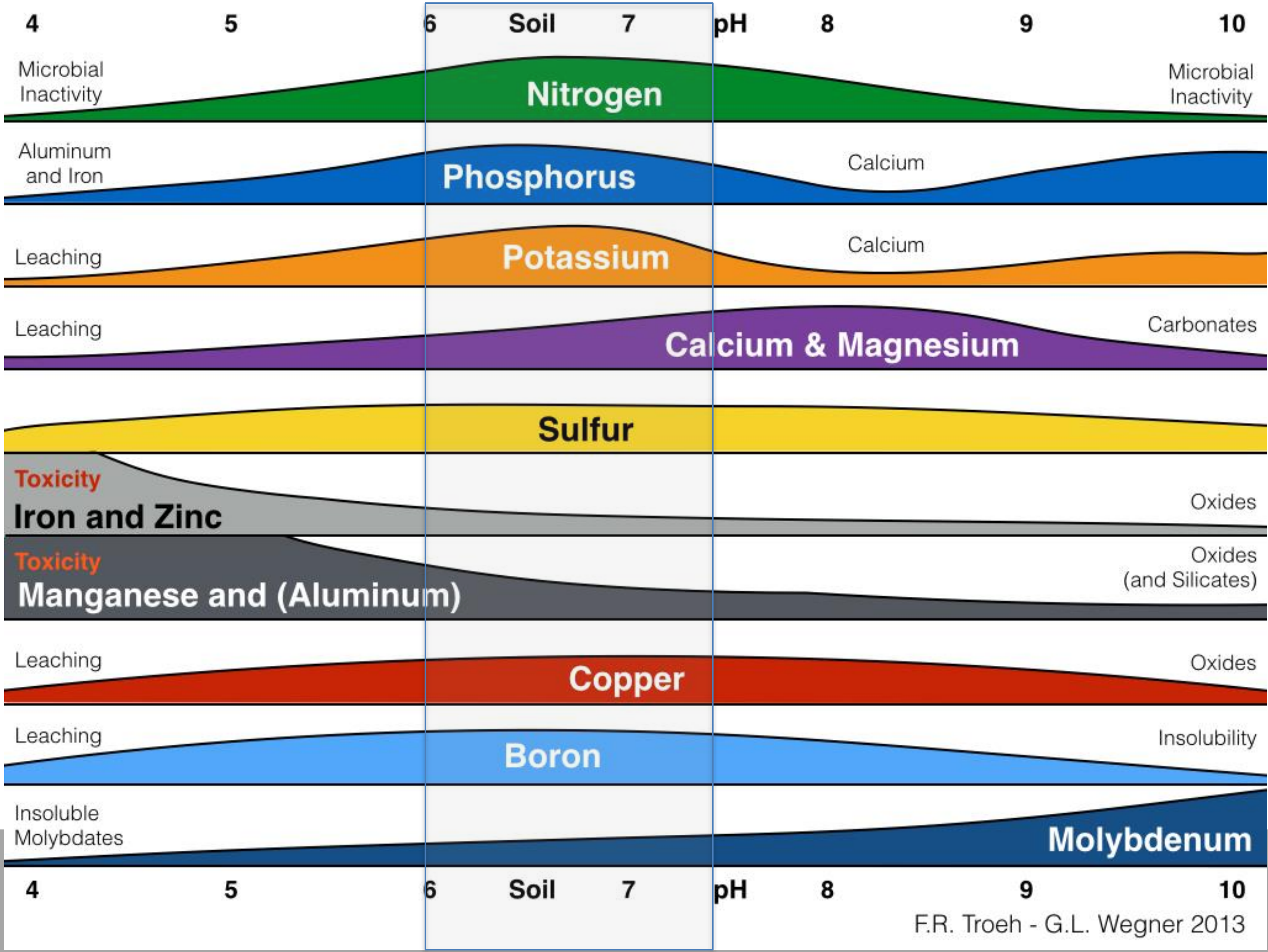
- Clays and Organics (humics) have net negative charge
- Results in a soil's CEC
- Tend to attract positively charged particles (ions)
- pH affects which particles



R.D. Voss, Iowa State

ACIDITY & THE GARDEN

- pH 6.0 – ~7.5 optimal for most plants
  - Nutrient cycling & availability



ACIDITY & THE GARDEN

- increase pH with ag-lime
  - incorporation
  - water
  - time

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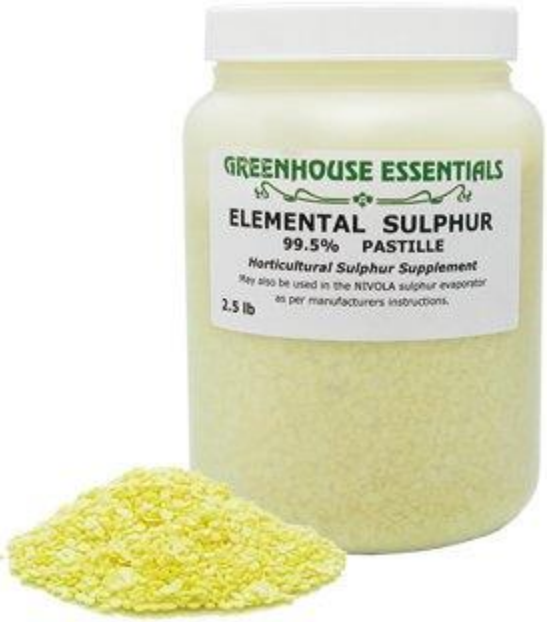
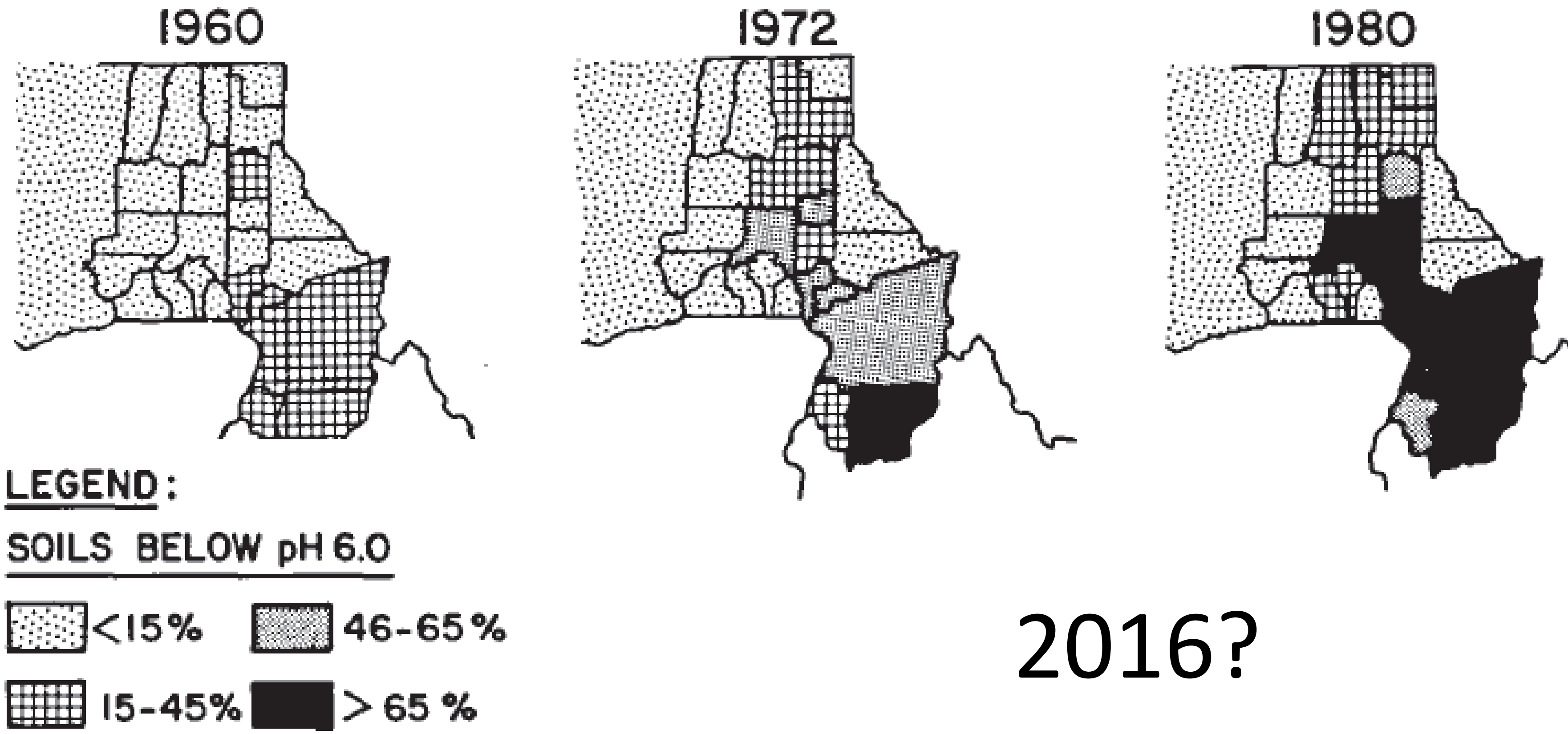
ACIDITY & THE GARDEN

- decrease pH with
  - elemental sulfur
  - pine needles, other organics



ACIDITY & THE FARM

- Up-scaled problem



2016?

PH SURVEY

Sample Analyses

- pH & OM
- Lime Requirement
- Base Saturation
- Plant Available Metals
  - Al, Mn, Fe
- Micronutrients
  - Boron, Zinc
- Macro's
  - N, P, K, S

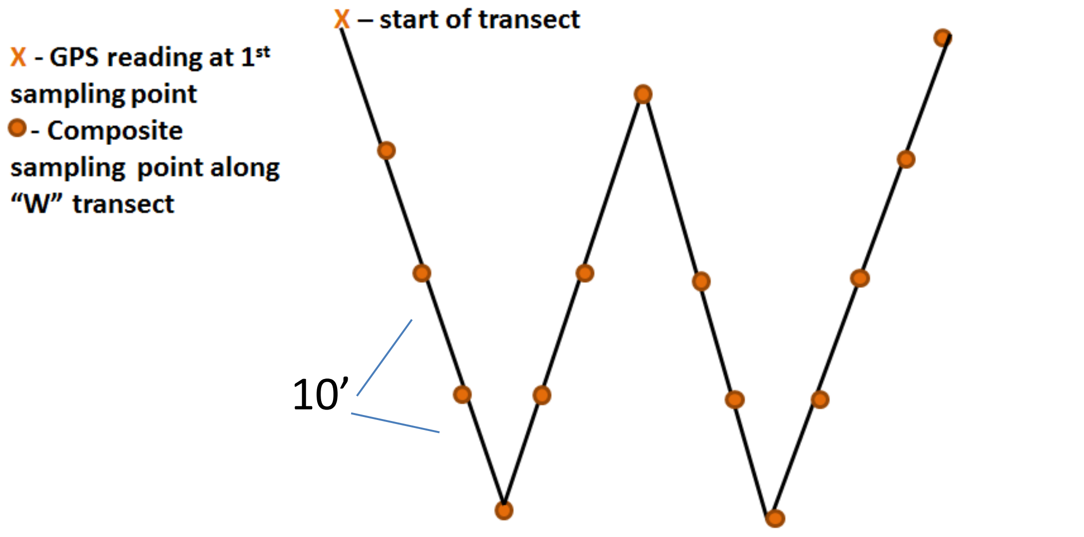


Figure 1. Transect pattern for soil pH survey composite sampling.

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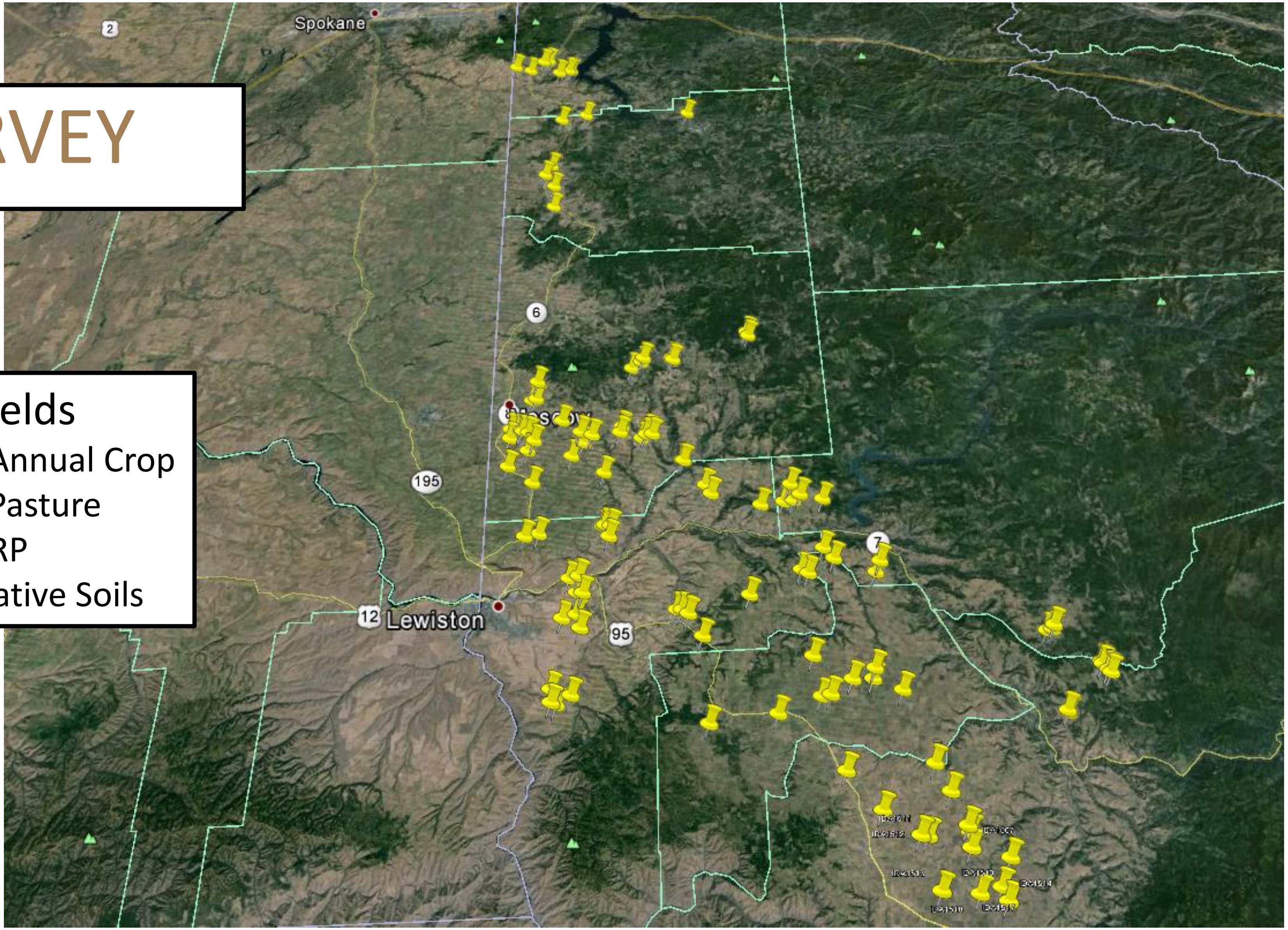
SURVEY

- 113 Fields
  - 95 Annual Crop
  - 11 Pasture
  - 5 CRP
  - 5 Native Soils



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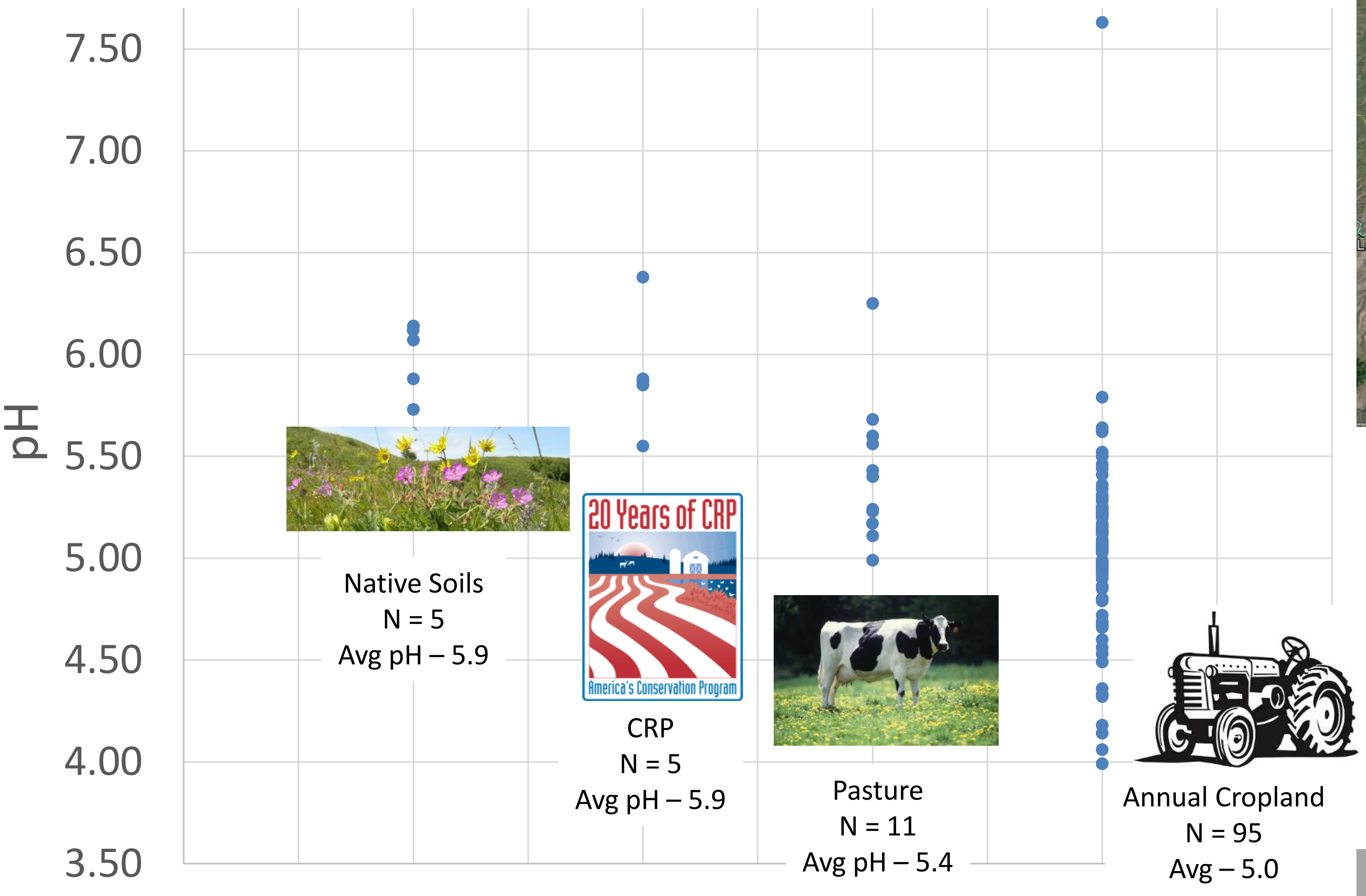
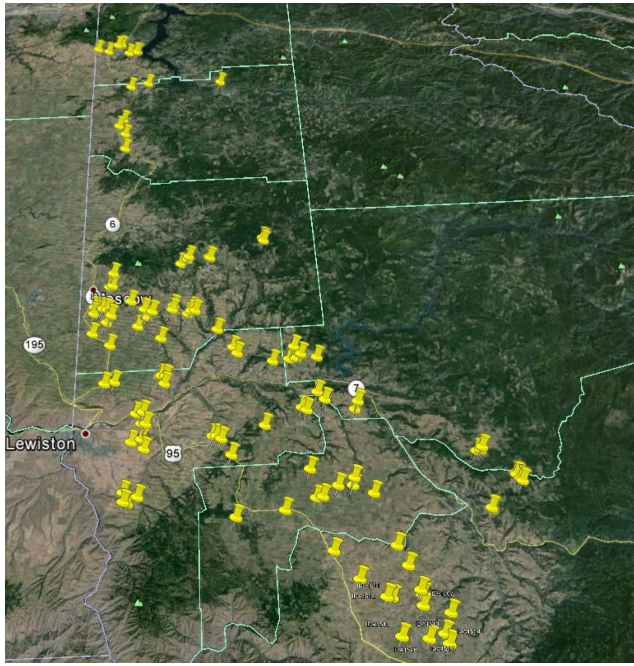
pH by sample type





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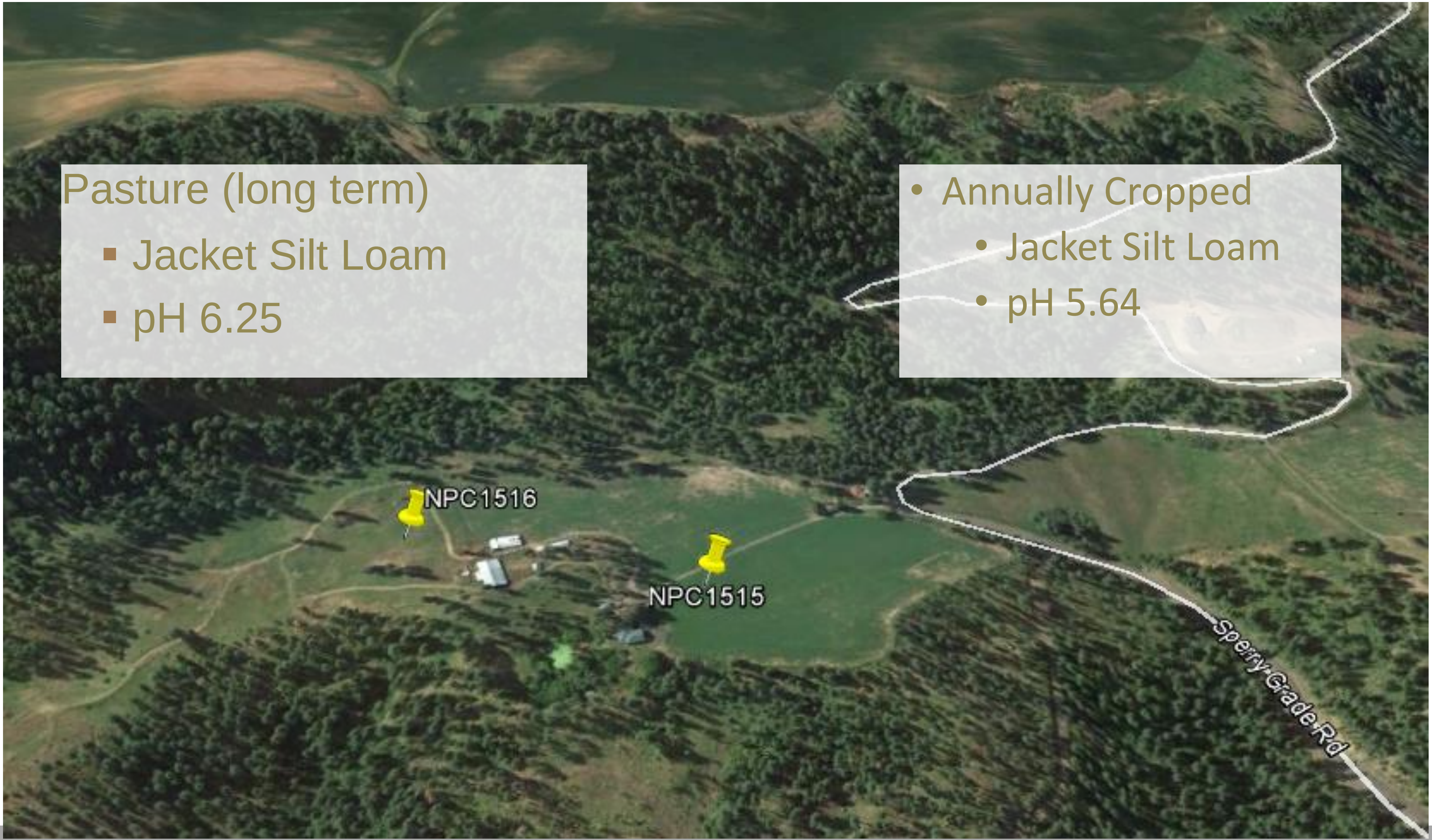
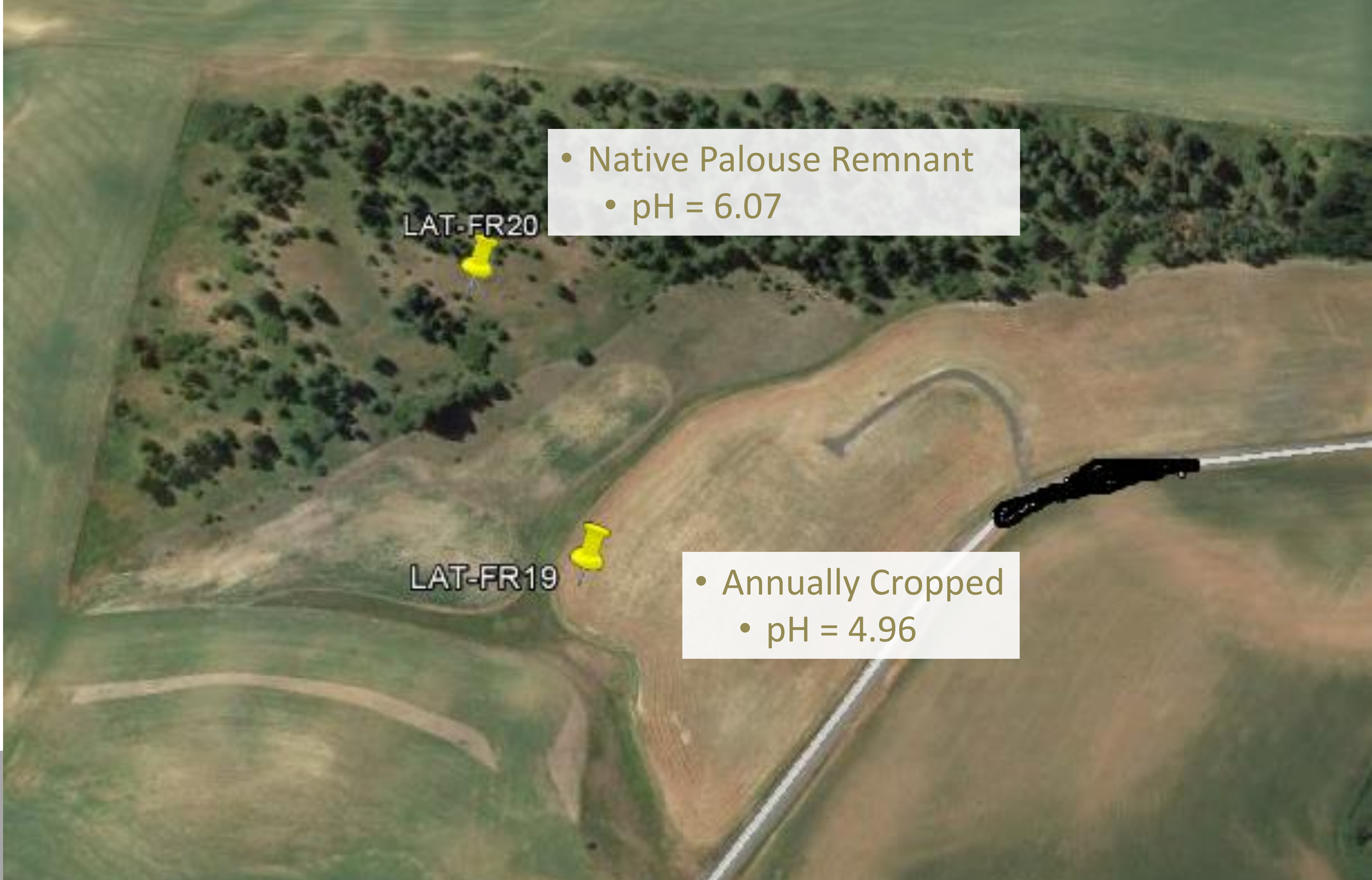
Pasture (long term)

- Jacket Silt Loam
- pH 6.25

- Annually Cropped
  - Jacket Silt Loam
  - pH 5.64

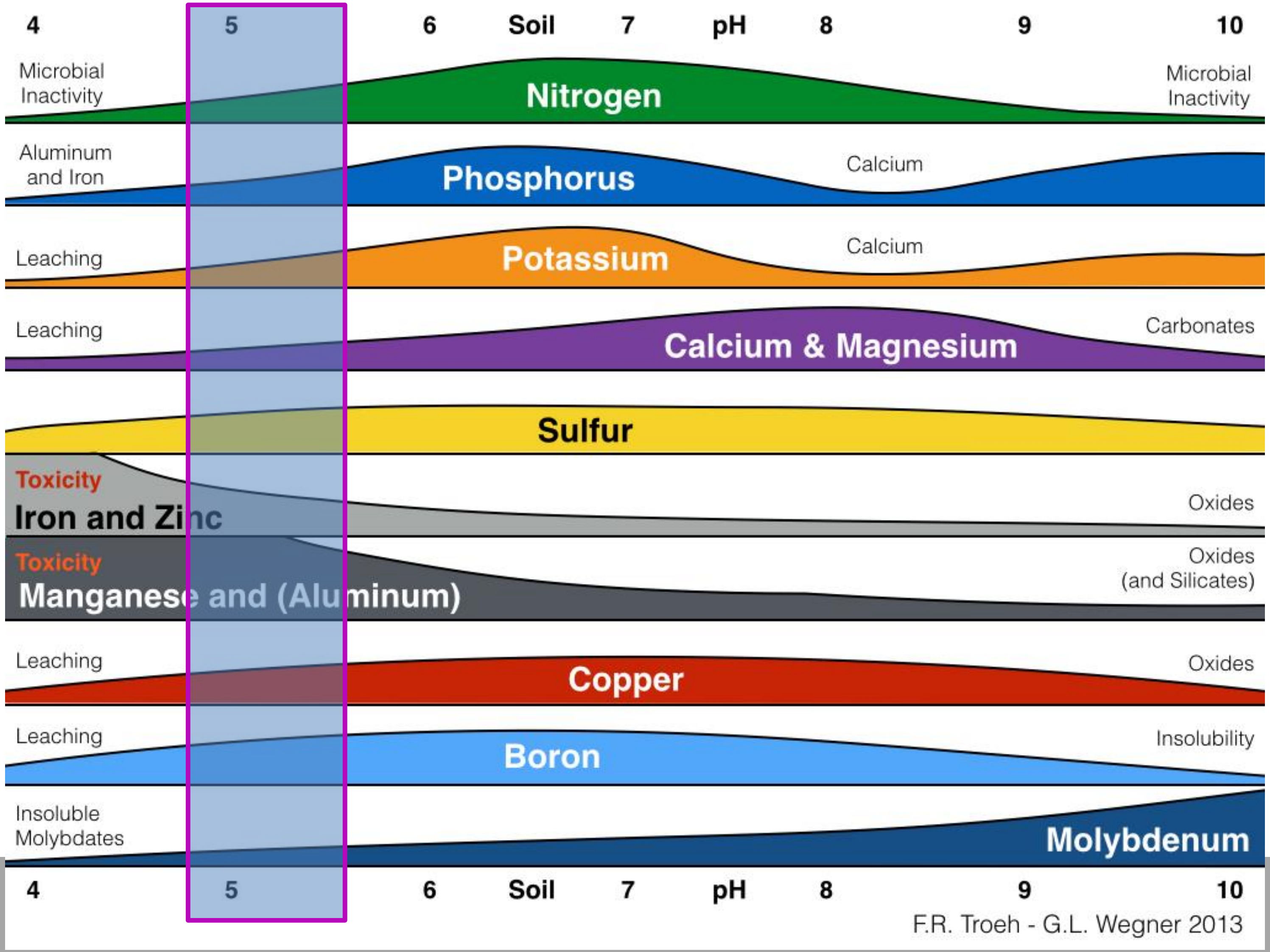




- Native Palouse Remnant
  - pH = 6.07

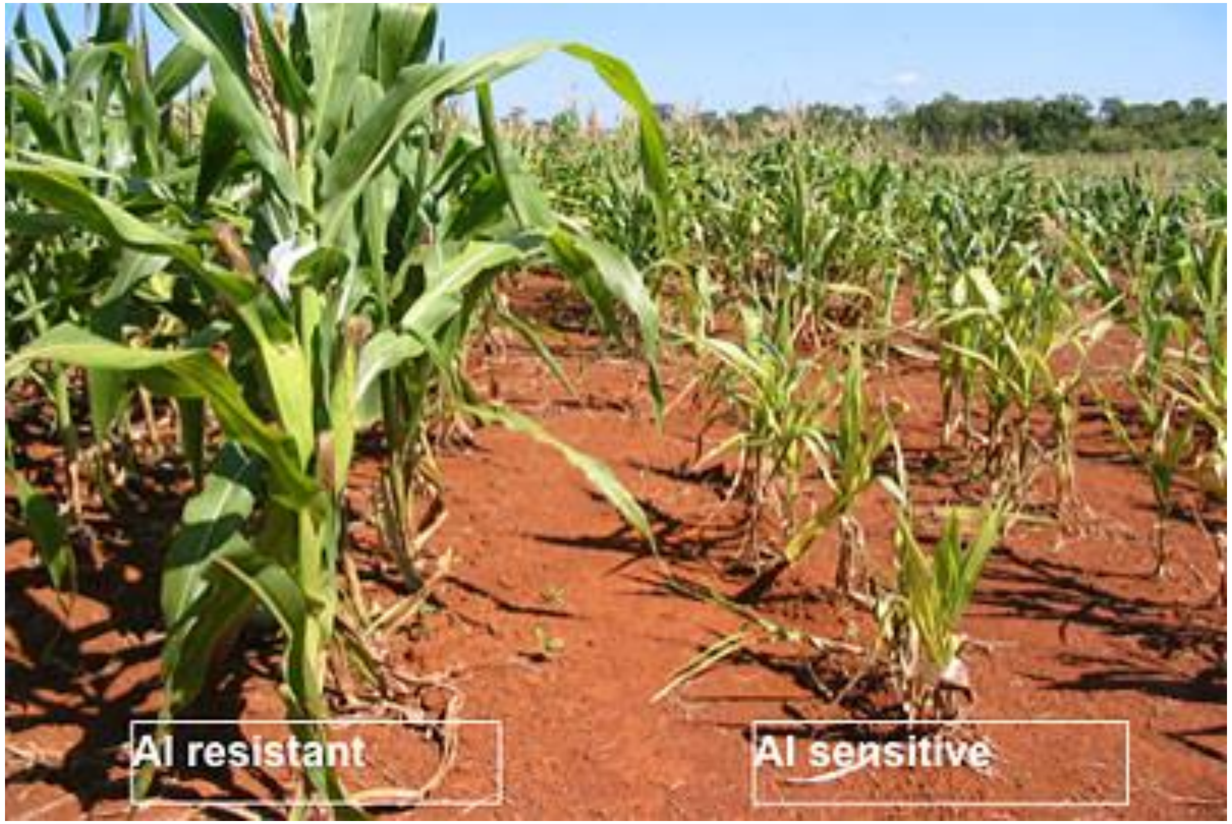
- Annually Cropped
  - pH = 4.96

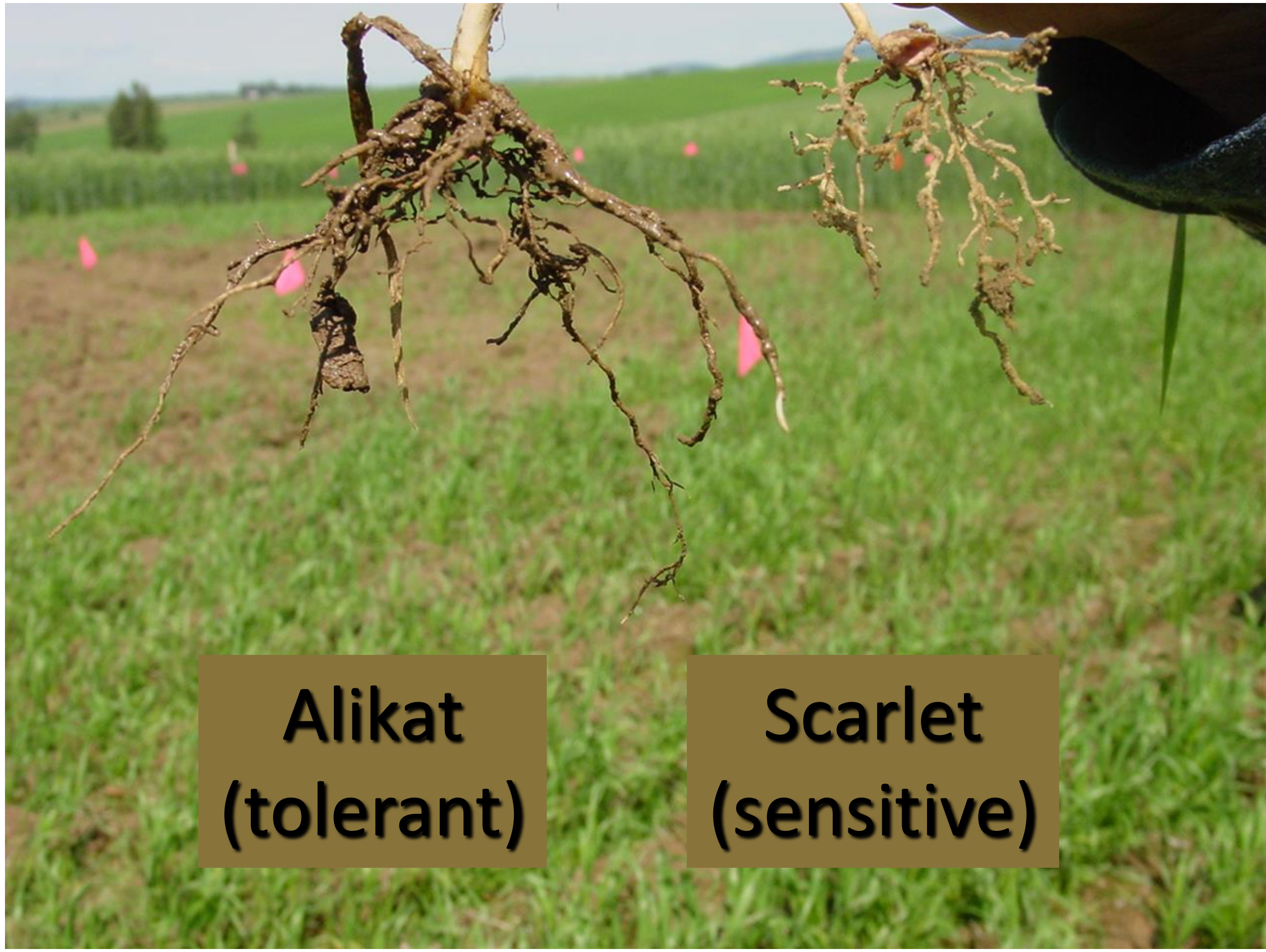
ACIDITY AND THE FARM



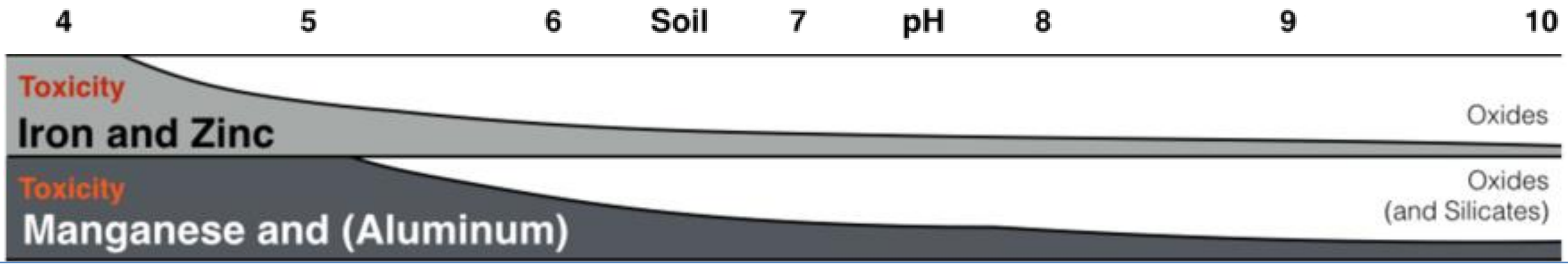
- Decrease in nutrient availability
  - Direct cost to producers
  - Indirect cost to society & environment
- Increase in (potentially) toxic metals – Al, Fe, Mn

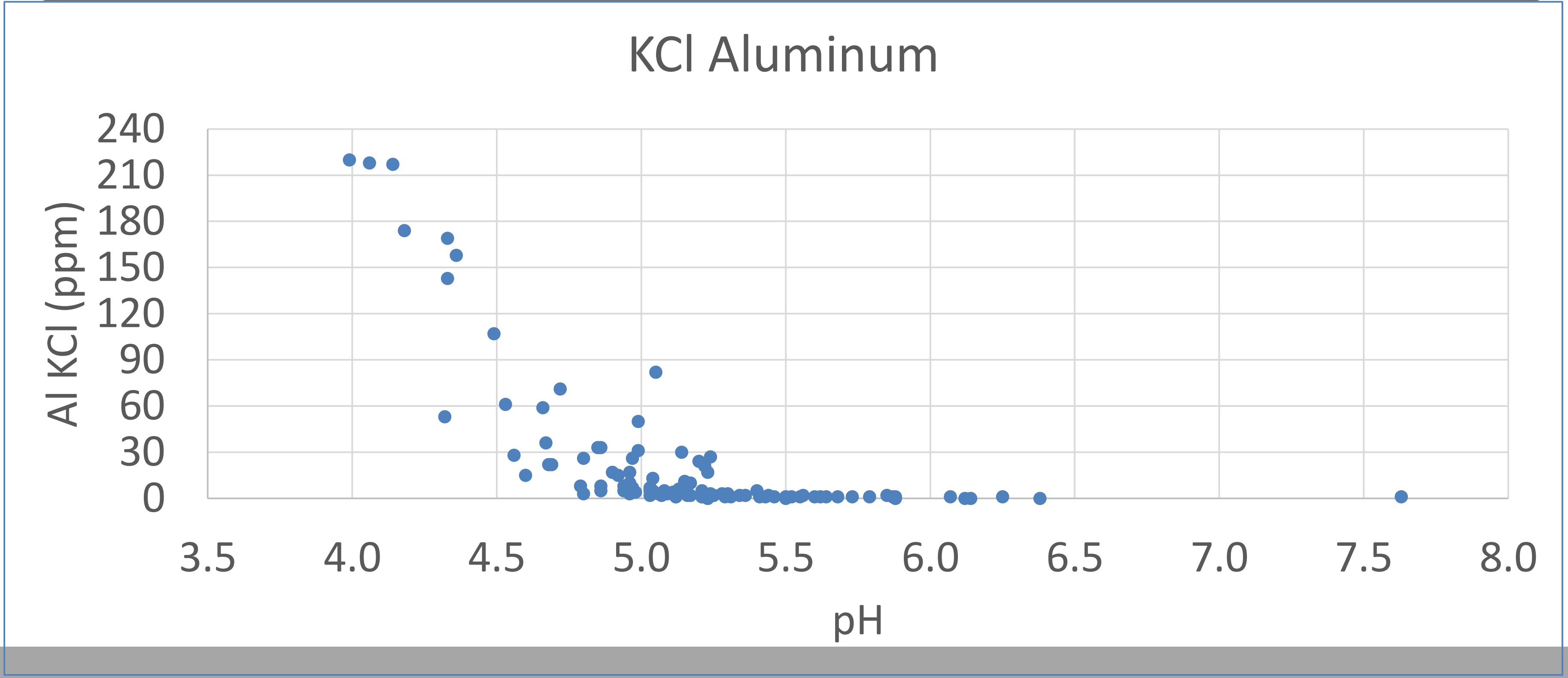
ALUMINUM TOXICITY





Nutrient availability/pH relationship





MANAGEMENT STRATEGIES

- Look under the hood…
    - Check your records - soil sample history
    - Change in susceptible crop productivity?
        - Reduced yields over time in lentils, peas, chickpeas ?
        - Trouble getting alfalfa established?

MANAGEMENT STRATEGIES

- Short Term
  - Choose tolerant varieties and crops: Wheat, Triticale, Oats, Grass Forage/Hay, Grass Seed
- Long Term
  - Adjust soil acidity with lime
  - Rotate low N-input crops more frequently (peas, lentils, chickpeas, alfalfa, barley, canola/rape)

Lime required to neutralize the soil acidity produced by common fertilizers

Nitrogen source	*Composition*	*Lime required (lb $CaCO_3$/lb N)*
Anhydrous ammonia	82-0-0	1.8
Urea	46-0-0	1.8
Ammonium nitrate	34-0-0	1.8
Ammonium sulfate	21-0-0-24	5.4
Monoammonium phosphate	10-52-0	5.4
Diammonium phosphate	18-46-0	3.6
Triple super phosphate	0-46-0	0.0

Adapted from Havlin et al., 1999

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ACIDITY & HERBICIDES

Soil Acidity Affects

- Herbicide Solubility
- Chemical Properties
- Charge – anion, cation, nonionic, nonpolar

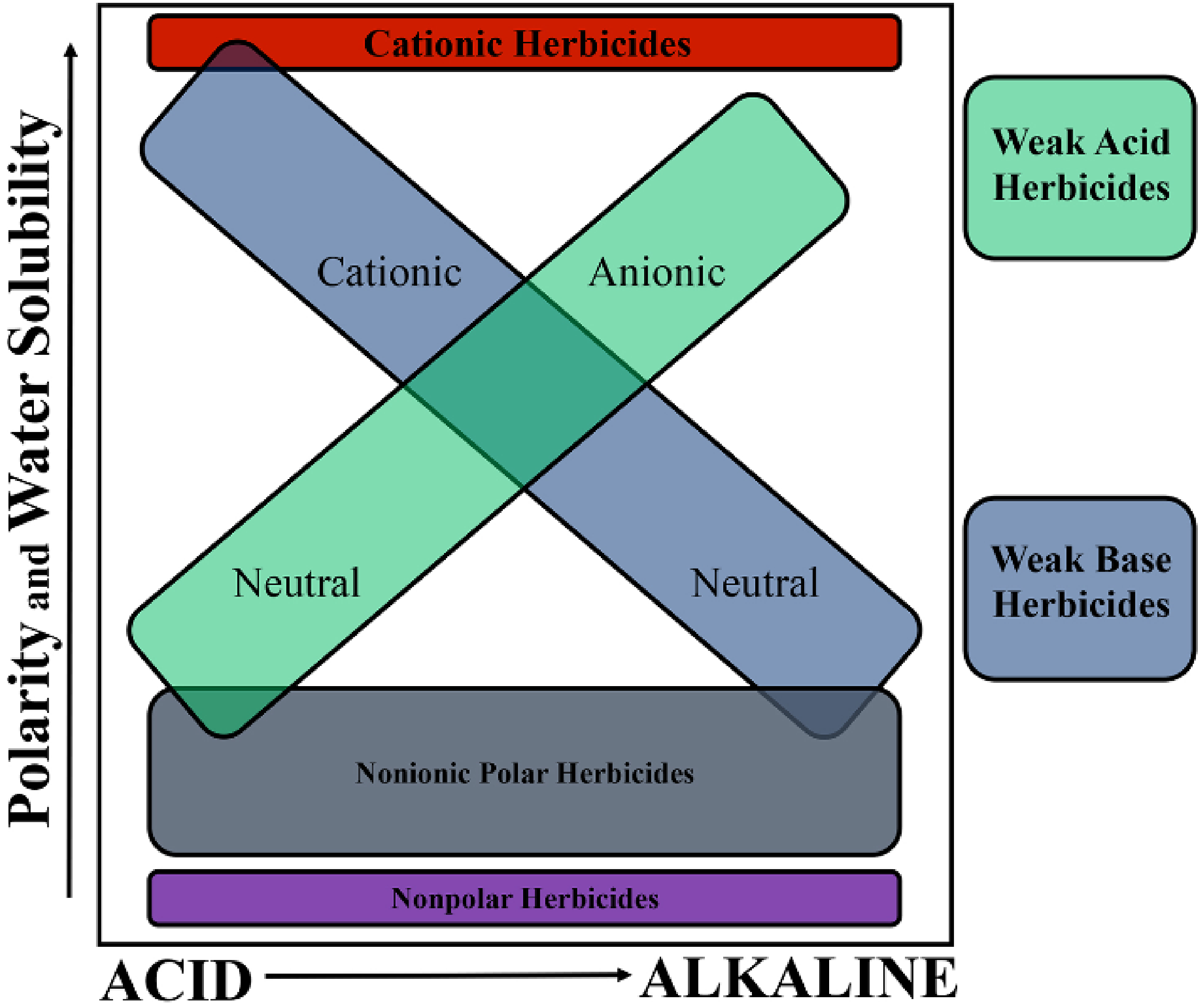
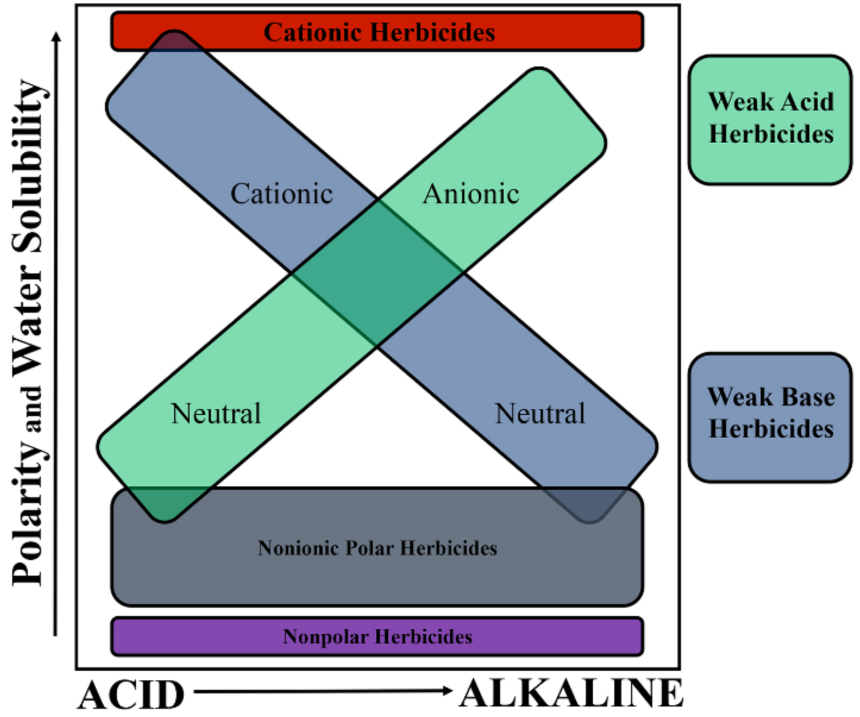


Figure 1. Classification of herbicides based on charge and polarity properties as pH changes from acid to alkaline. Adapted from Environmental Chemistry of Soils (McBride 1994).

http://cru.cahe.wsu.edu/CEPublications/FS189E/FS189E.pdf

HERBICIDES AND SOIL ACIDITY - IMIDAZOLINONES

- Weak acid
- Soil acidity increases persistence
- Become less soluble in water
- Associates with solid phase



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BEYOND HERBICIDE | CLEARFIELD® PRODUCTION SYSTEM

Clearmax® herbicide

Pursuit® herbicide

Raptor® herbicide

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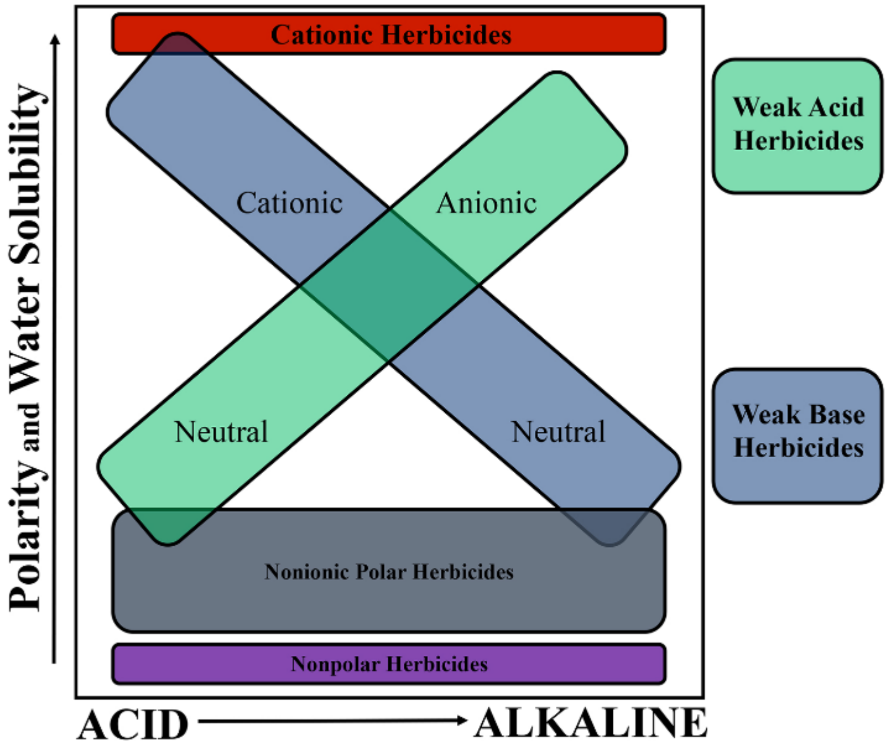
HERBICIDES AND SOIL ACIDITY - TRIAZOLOPYRIMIDINES

- Weak Acids
- Soil Acidity Increases Persistence
- Neutral charge in acidic conditions
- Become less soluble in water
- Associates with OM
- Less available to microbes



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HERBICIDES AND SOIL ACIDITY

Crop Rotation Intervals for Idaho, Oregon, and Washington
Superscripted numbers refer to Crop Specific Rotation Information.

<table>
<tr><th rowspan="2">Crop</th><th colspan="2">Rotation Interval (Months)[1]</th></tr>
<tr><th>Soil pH >6 and Rainfall[2] >16 Inches</th><th>Soil pH <6 or Rainfall[2] <16 Inches</th></tr>
<tr><td>wheat, triticale</td><td>1</td><td>1</td></tr>
<tr><td>barley, field corn, grasses, millet, oats, popcorn, seed corn, sweet corn, grain sorghum</td><td rowspan="3">10</td><td rowspan="2">10</td></tr>
<tr><td>alfalfa, camelina, canola, cotton, dry bean, flax, mustard, peanuts, safflower, soybean, sugar beet, sunflower</td></tr>
<tr><td>pulse crops[3] including chickpea, lentil, and pea (dry and succulent), potato[3]</td><td rowspan="2">18</td></tr>
<tr><td>other crops not listed</td><td>12</td></tr>
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PowerFlex HL
HERBICIDE

GoldSky
HERBICIDE

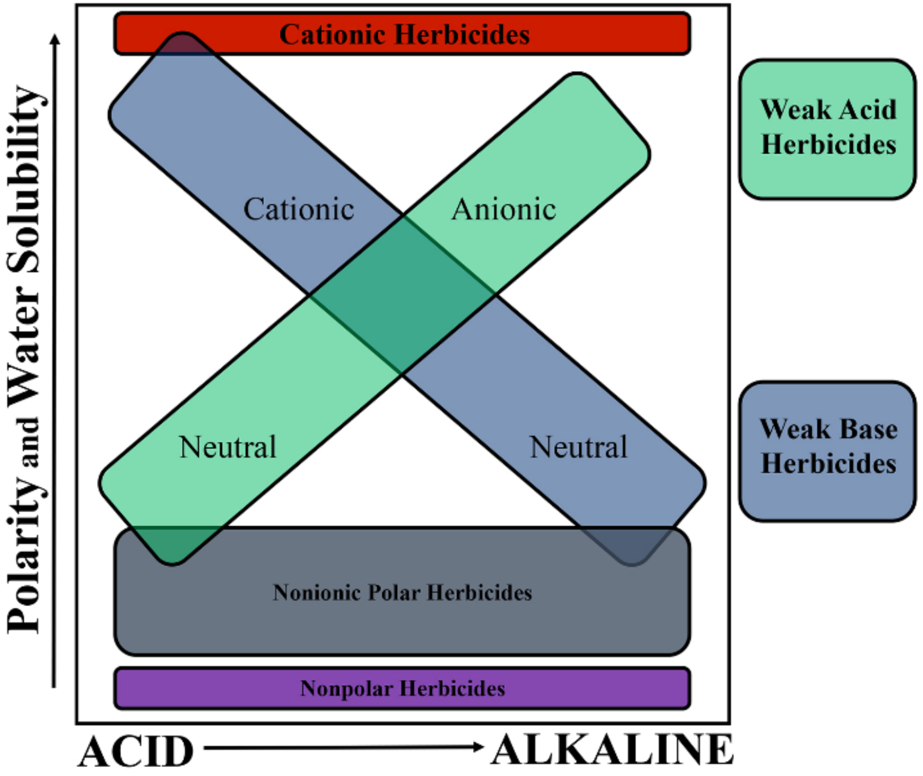
HERBICIDES AND SOIL ACIDITY - SULFONYLUREAS

- Weak acids
- Increasing water solubility at higher pH's…..***but….***
- Chemical degradation at low pH's
- Less persistent in acid soils

- Glean
- Osprey
- Olympus
- Peak
- Matrix
- Oust
- Harmony
- Amber
- Express

HERBICIDES AND SOIL ACIDITY - TRIAZINES

- Weak Bases
- Low pH Decreases Effectiveness
- Become cationic in acid conditions
- Binds to negatively charged soil



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AXIOM® DF Herbicide

Sencor®

TRICOR® DF HERBICIDE

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What to do...?

HERBICIDES AND SOIL ACIDITY - NONIONICS

- Primarily degraded by microbes
- Soil Temperature
- Soil Moisture
- ~pH (fungi/bacteria)

Lorox

Valor

Axiom

Zidua

HERBICIDES AND SOIL ACIDITY - GLYPHOSATE

- Weak acid
- Not pH sensitive
- Has negative charged functional group
- Binds tightly to cations in soil

HERBICIDES AND SOIL ACIDITY - 2, 4-D

- Weak acid
- Water solubility changes by formulation (acid < amine < ester)
- pH doesn’t affect solubility

SUMMARY

- Soil acidity affects soil biology, nutrient cycling, plant toxicity, and can effect weed control.
    - Herbicide group not important
    - Charge and polarity of herbicide important
- Soil acidity directly affects nutrient cycling
    - Can result in poor nitrogen use efficiency, less available essential nutrients and in extreme cases plant toxicity

CONTACT INFORMATION

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