

John Lee – AGVISE Soil Scientist

Where did it all start?

Sandbox where I made my first “Mud” pie



20:23

17.30

0.32

2.79

26.88

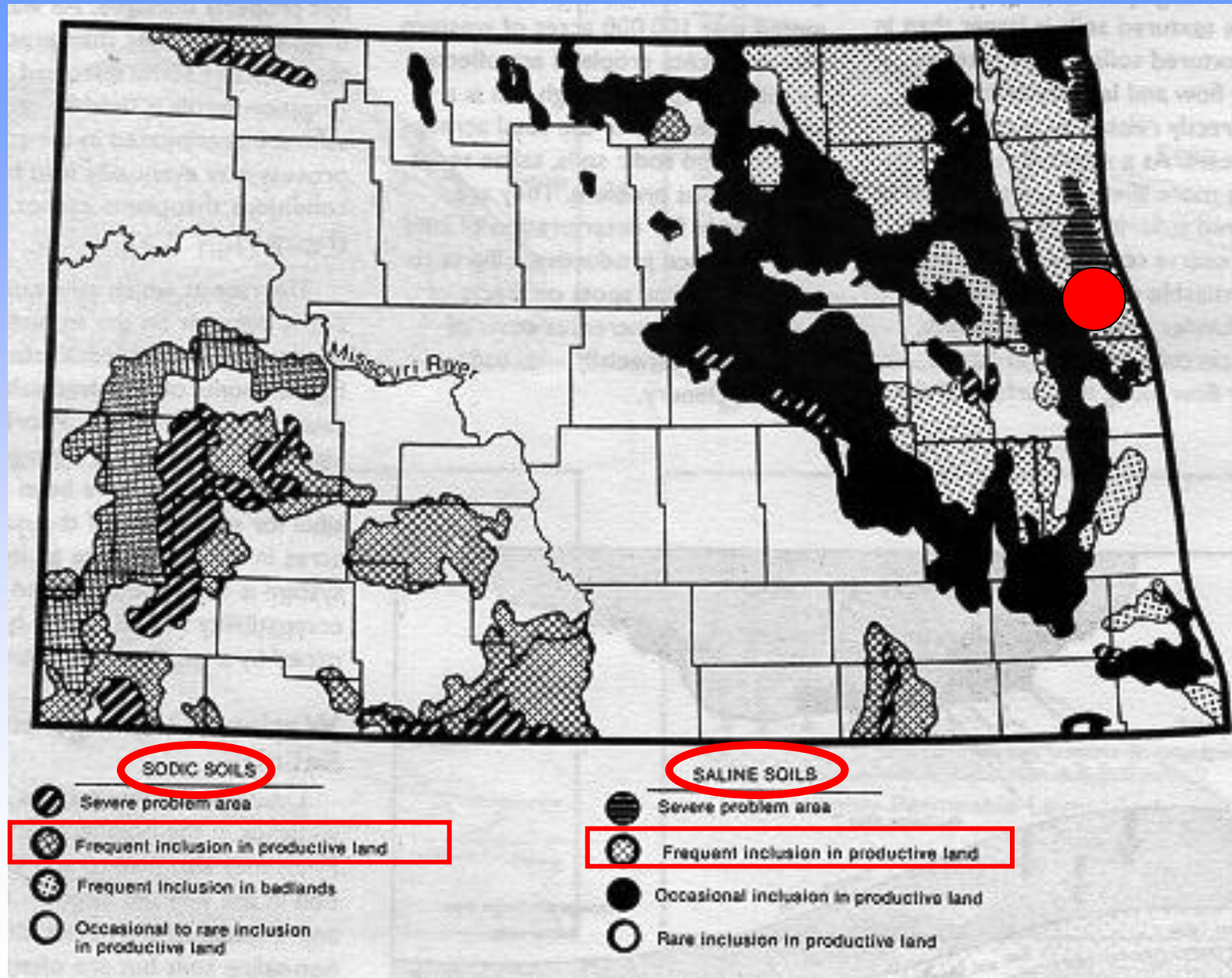
3.97

Sodic Soil Reclamation Tiled Drained Situation



AGVISE Demo Project 2008 to ????

Saline & Sodic Soils in North Dakota



Sodic Soil Reclamation

- Sodic soil areas being recognized locally
 - Tile drainage is revealing areas of sodic soils
 - As the salts are leached from the soil by the tile drainage, the sodium issue becomes more apparent
 - Reclamation with gypsum in these sodium affected areas is necessary to improve productivity

Soil Productivity

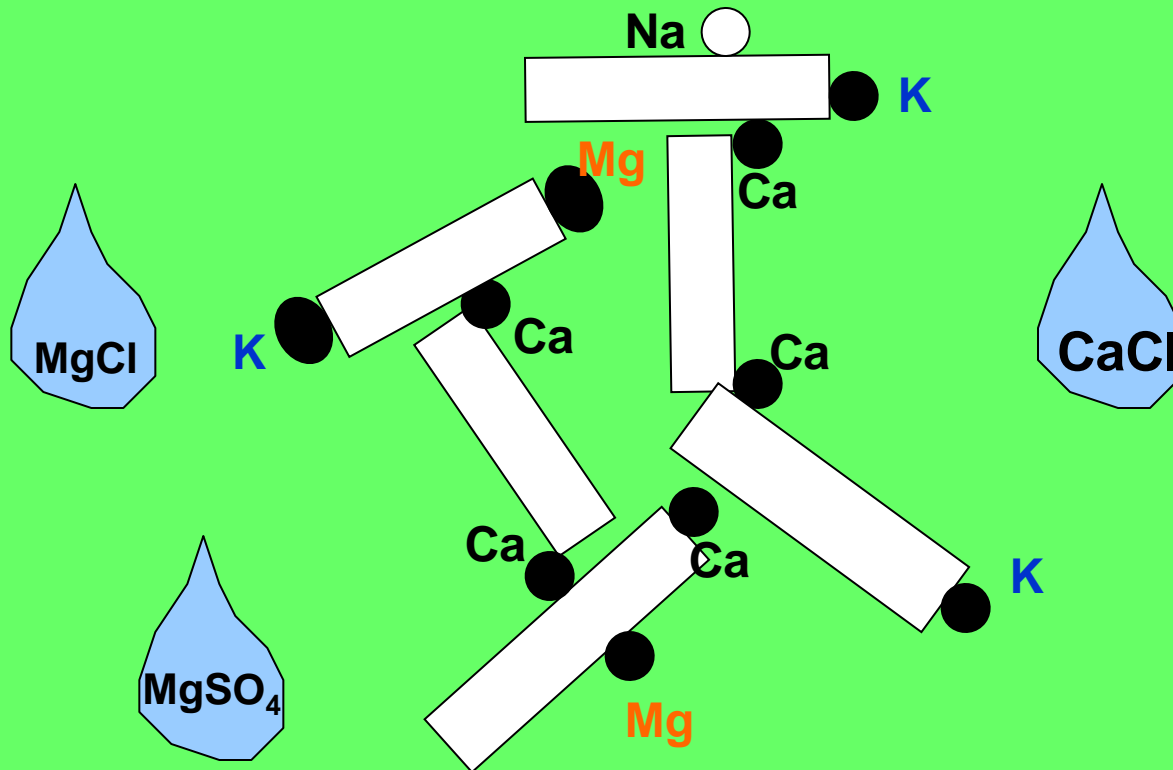
Based on Salinity and Sodium Level

- Good Productivity
 - Non saline
 - Non-sodic
- Moderate Productivity
 - Moderate salinity
 - Non-sodic
- Low Productivity
 - Moderate to high salinity
 - Moderate to high sodium level

Good Productive Soil

Good structure, good water infiltration, soft when dry

Low salt (less than 1.0 mmhos/cm) Low sodium (less than 2% sodium)

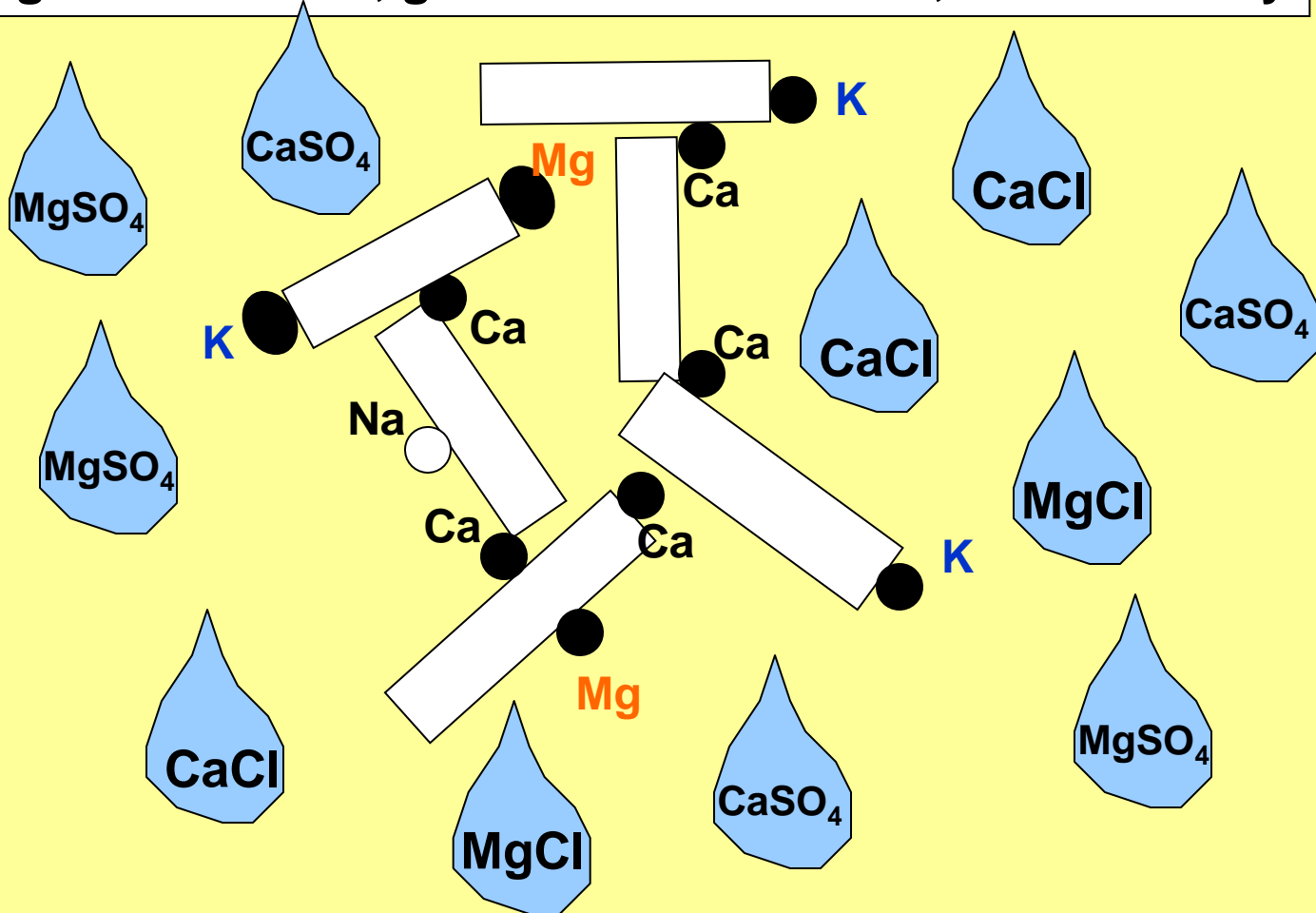


Saline (Salty) Soil

- Saline soils are caused by a water near the soil surface for at least part of the year.
- Saline soils have an electrical conductivity value (e.c.) value greater than 2.0 mmhos/cm (1:1 routine test run by all laboratories)
- Saline soils usually have a white surface and have good structure (they feel soft)
- Saline soils cause yield loss in many crops in the Montana, the Dakotas and western MN.
- Saline soils can be low or high in sodium

**Saline Soils (salt greater than 2.0 mmhos/cm)
Sodium is low (less than 4%)**

good structure, good water infiltration, soft when dry



Osmotic affect caused by Salts hurt plant growth

Saline Soil Classes

*** Based on routine laboratory 1:1 soil to water method**

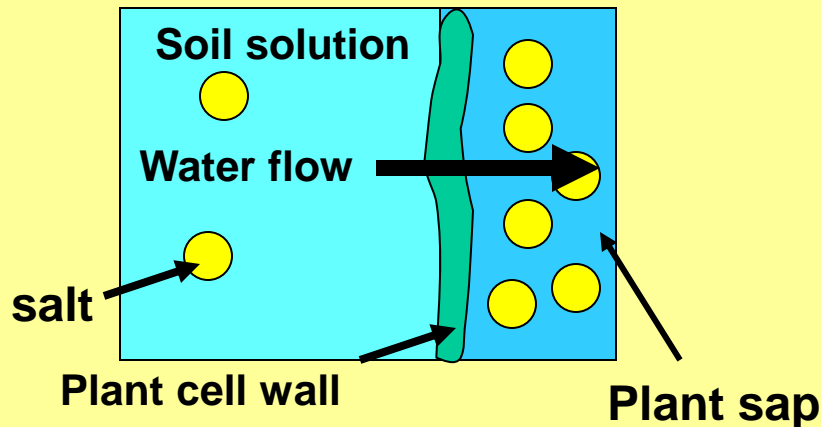
Salinity Class	* E.C. Value (mmhos/cm)	Influence on crop yield
Non-saline	0.0-0.5	None
Very slightly saline	0.6-1.0	Sensitive crops may have yield reduction
Mod Saline	1.1-2.0	Yields of many crops reduced
Strongly saline	2.1-4.0	Yields of most crops reduced
Extremely saline	Greater than 4.0	Few plants will grow

Table represents medium and fine textured soils

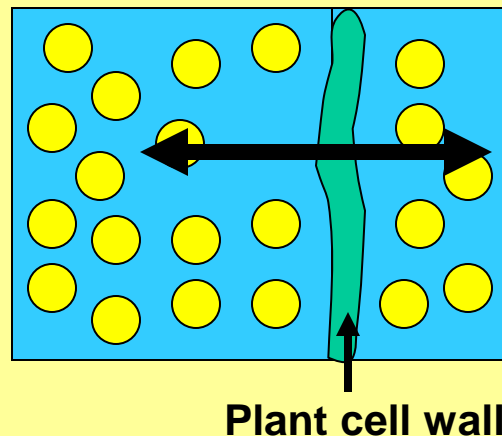
Saline Soil (white salt)

Osmotic affect restricts plant growth: In normal soil, plant sap has a higher salt concentration than the surrounding soil water solution. This causes water to come into the plant through the root, to equalize the concentration of salts (osmosis). If the soil solution has a higher salt concentration than the plant sap, water stops flowing into the plant. The plant dies of “water stress” even though the soil is very wet.

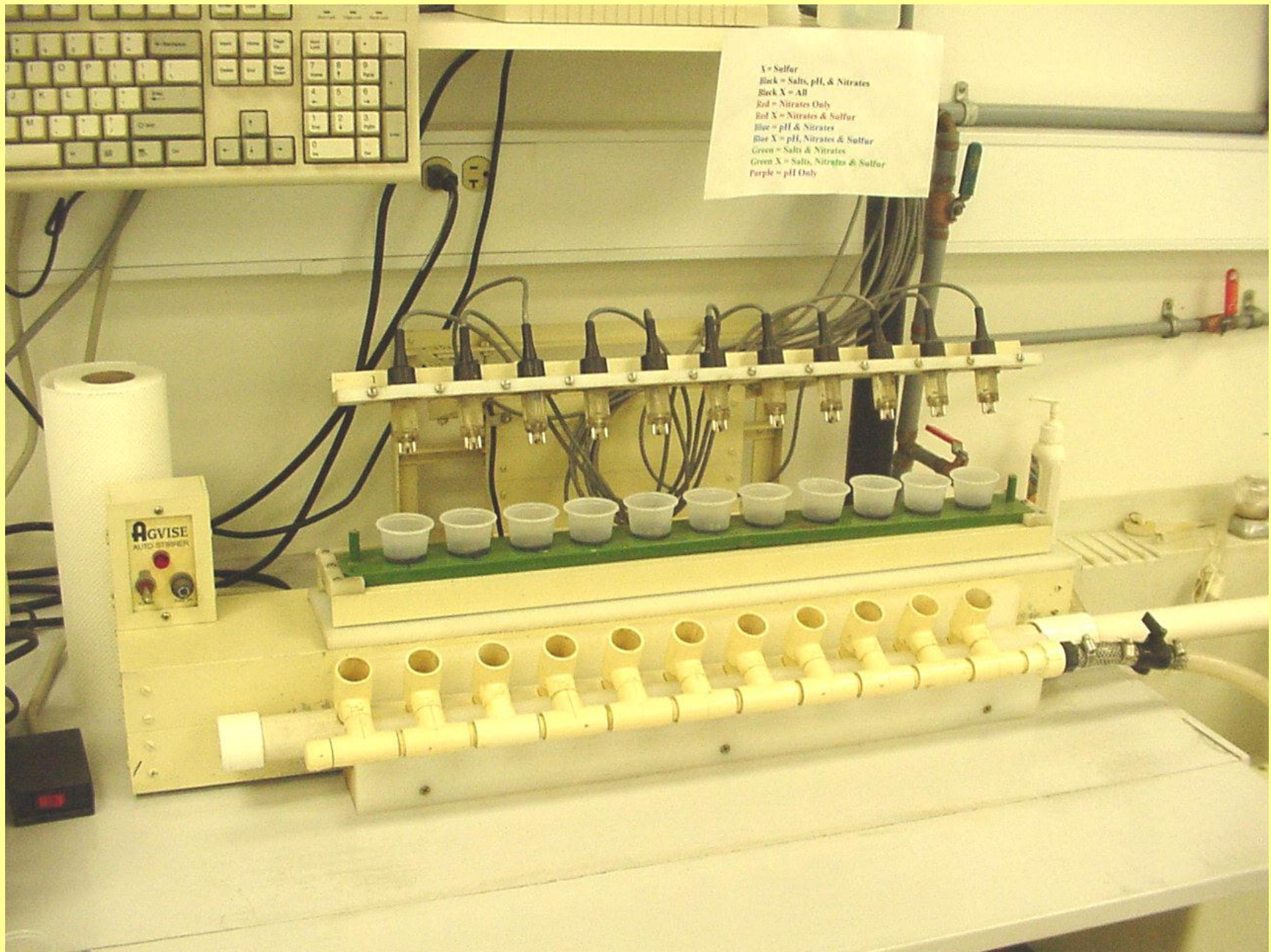
**Normal soil water
flows into plant.**



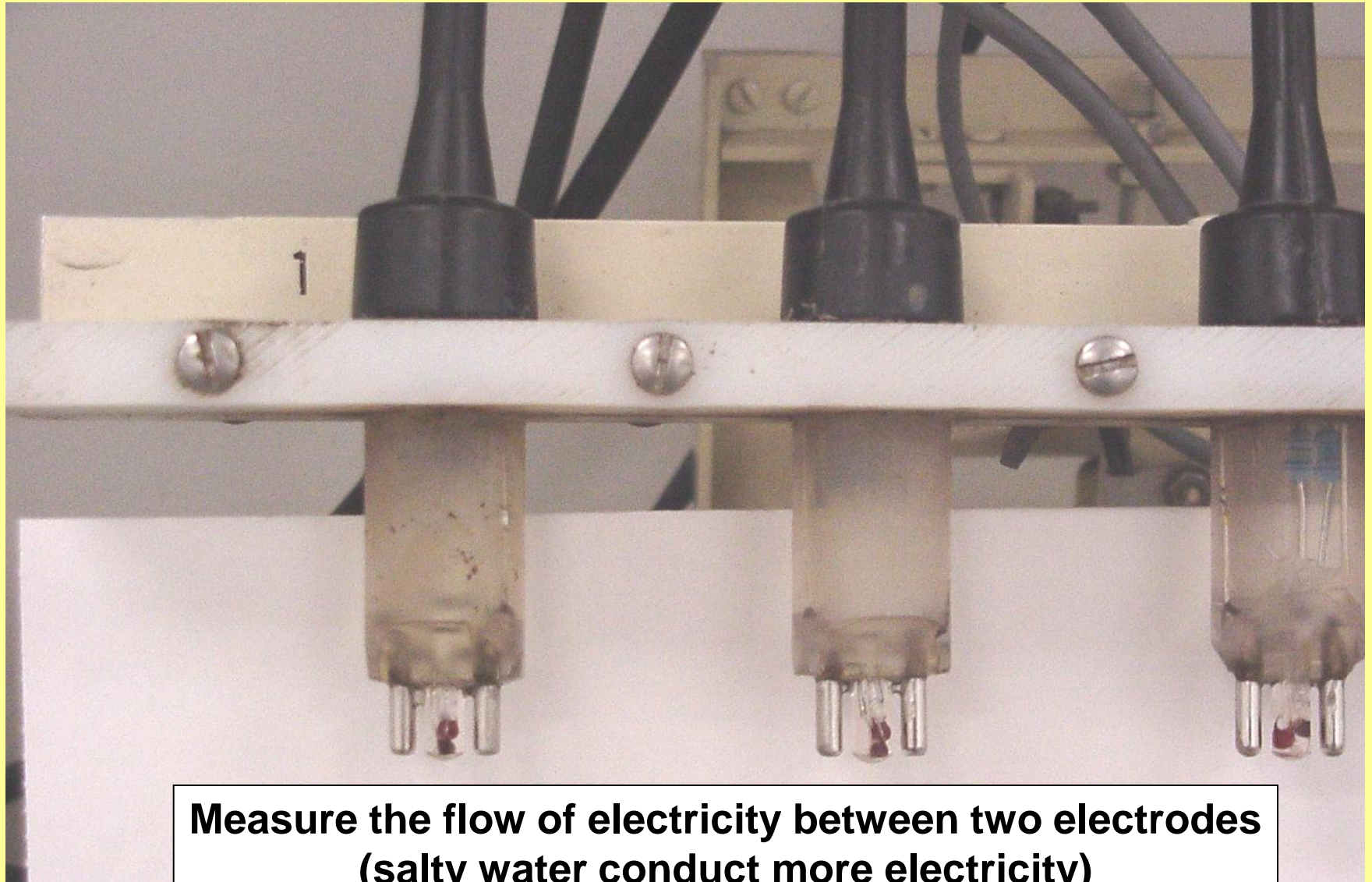
**Saline soil water flow into
the plant is restricted or stopped.**



Salinity/Electrical Conductivity Test



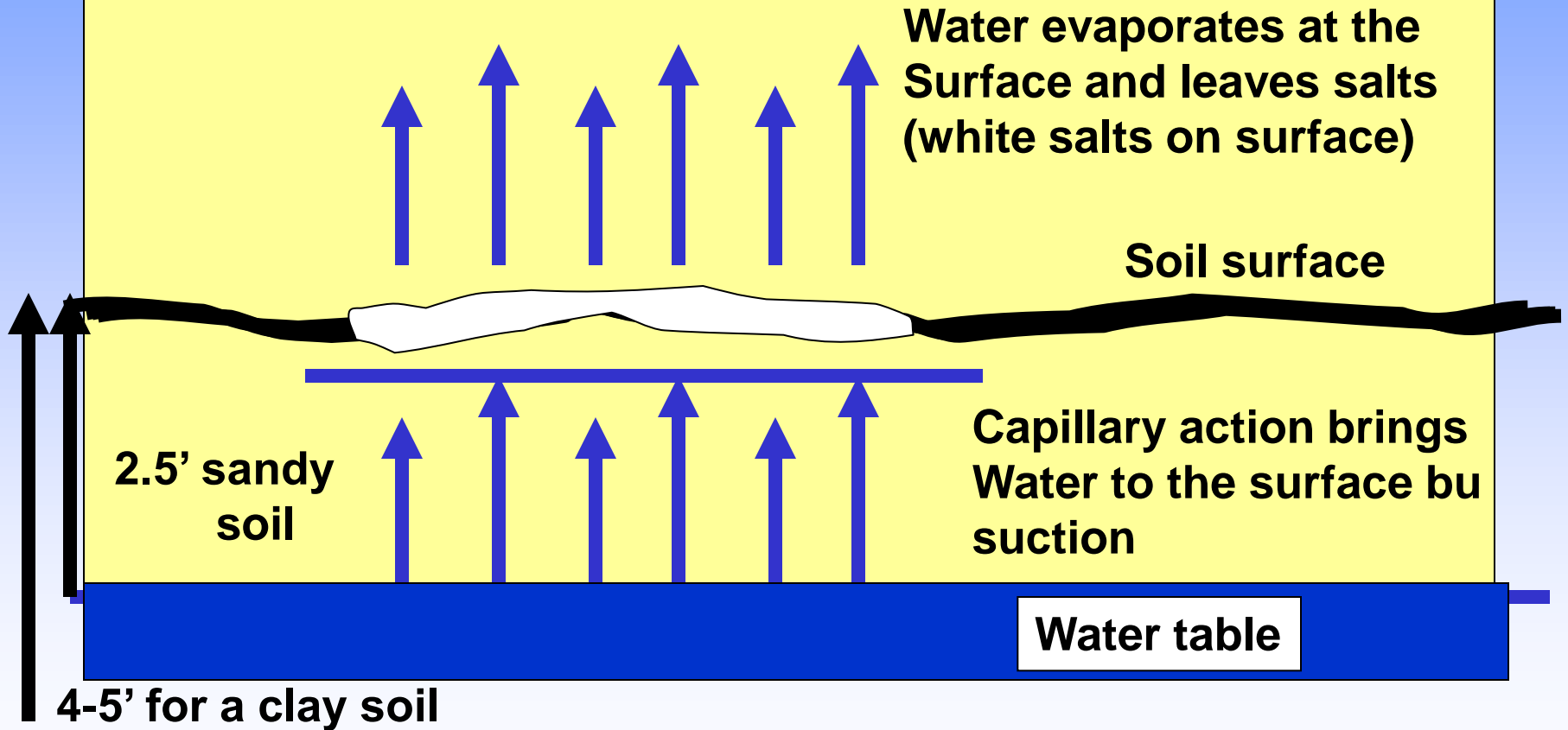
Salinity/Electrical Conductivity Test



**Measure the flow of electricity between two electrodes
(salty water conduct more electricity)**

Saline Soils

- How do soils become saline?



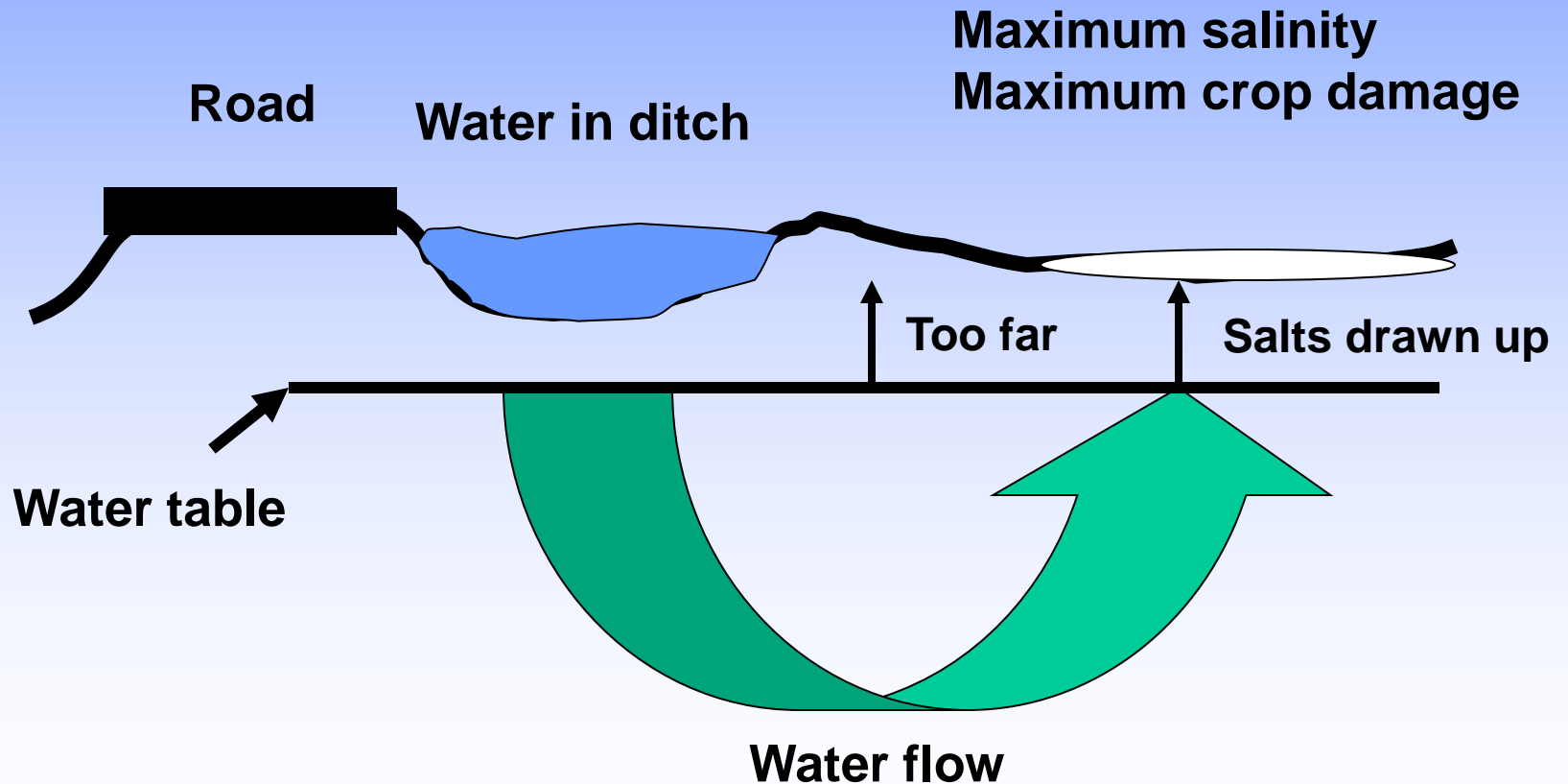
A series of wet years will bring the water table closer to the surface and salt levels will increase at the surface increasing saline area size

Salinity Near Drainage Ditch



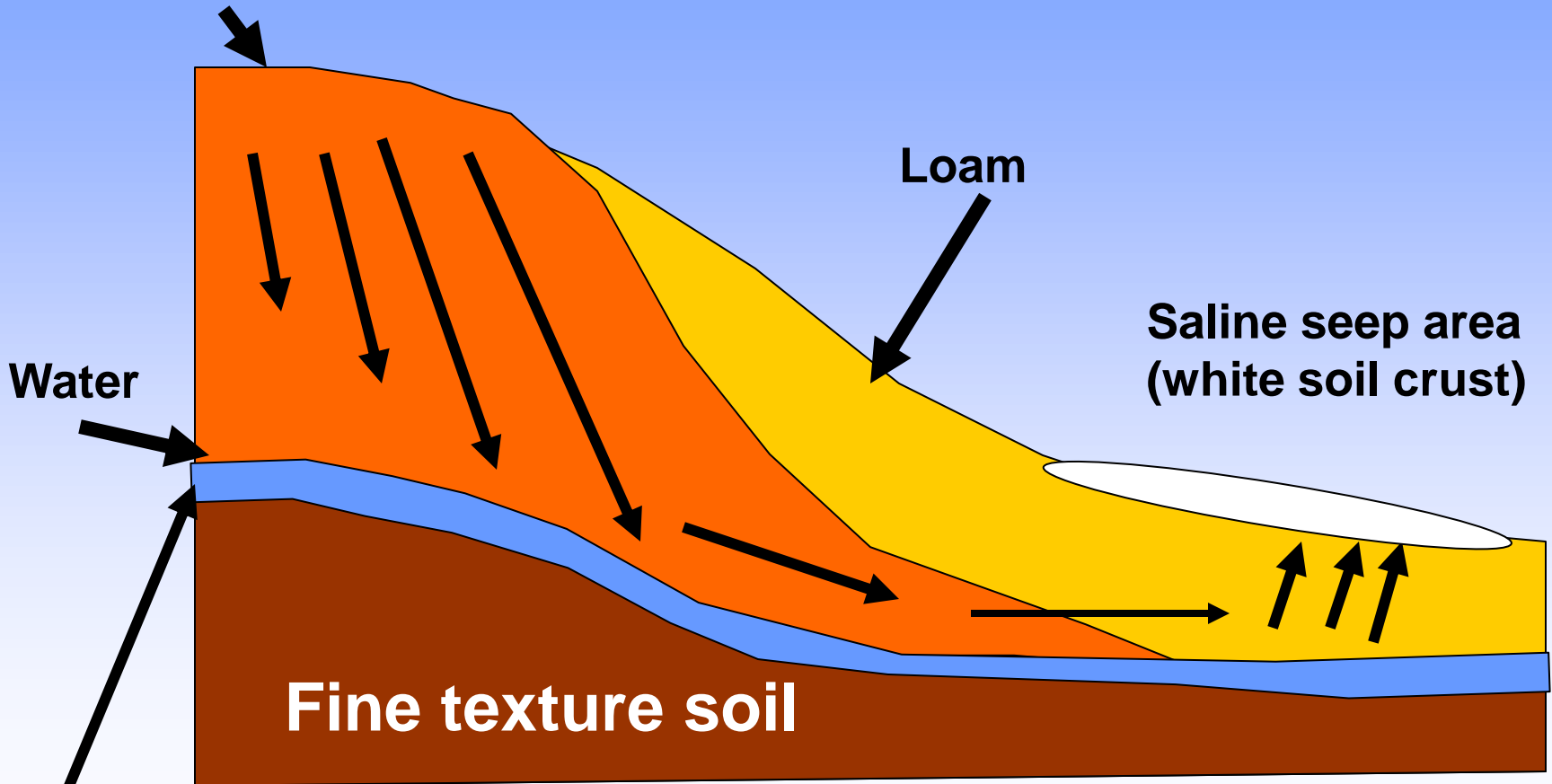
Saline Soils

Saline soil beside drainage ditch



Saline Soils - Seeps

How saline seeps develop



(Recharge area)
Sandy loam

Loam

Saline seep area
(white soil crust)

Water

Fine texture soil

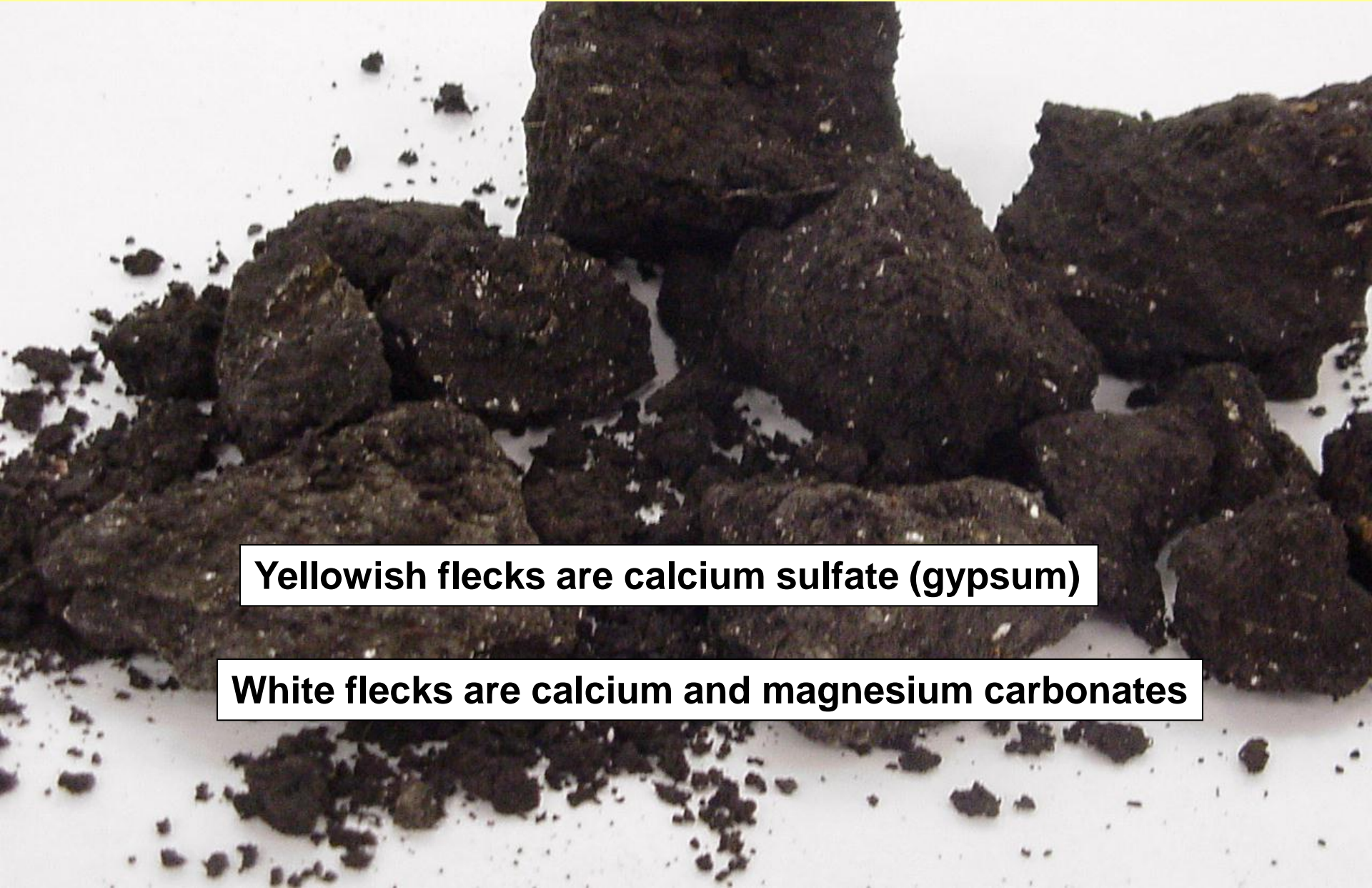
Coarse soil material acts like pipe

***Saline Soil
Limits plant growth***



Kochia (Christmas Trees?)

Saline Soil Structure



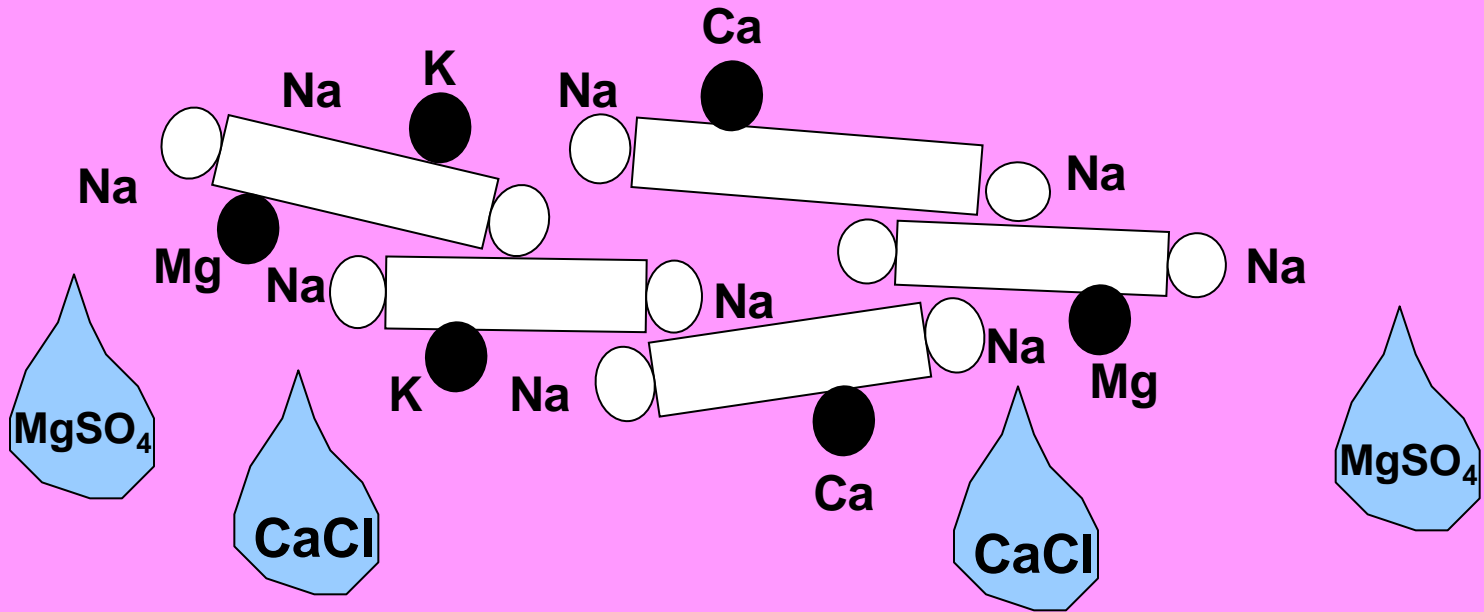
Yellowish flecks are calcium sulfate (gypsum)

White flecks are calcium and magnesium carbonates

Sodic Soil

Poor structure (pudding when wet), poor water infiltration, hard when dry

High sodium (4-15% sodium) Low salt (less than 2.0 mmhos/cm)



Excessive sodium causes soil particles to orient in layers and seal

ICP- Testing for sodium, calcium, magnesium, potassium



Sodic Soil

- Soil Test Levels
 - >3-5% sodium on base saturation, soil surface begins to seal infiltration reduced
 - >15% sodium is defined as sodic soil
 - pH greater than 8.3- 8.5
- Physical problems due to sodium
- Sodic soils can occur naturally
- Many sodic soils in this region are created by poor irrigation techniques
- Some sodic soils also have high salinity

Sodic Soil

- Physical problems
 - High sodium destroys soil structure (wet pudding)
 - High sodium seals surface (poor infiltration)
 - High sodium reduces water percolation through the soil profile.
 - When a sodic soil becomes dry it becomes hard like a brick!
 - Sodium can be toxic to plants at high levels

Sodic Soil ***Destroyed Structure***



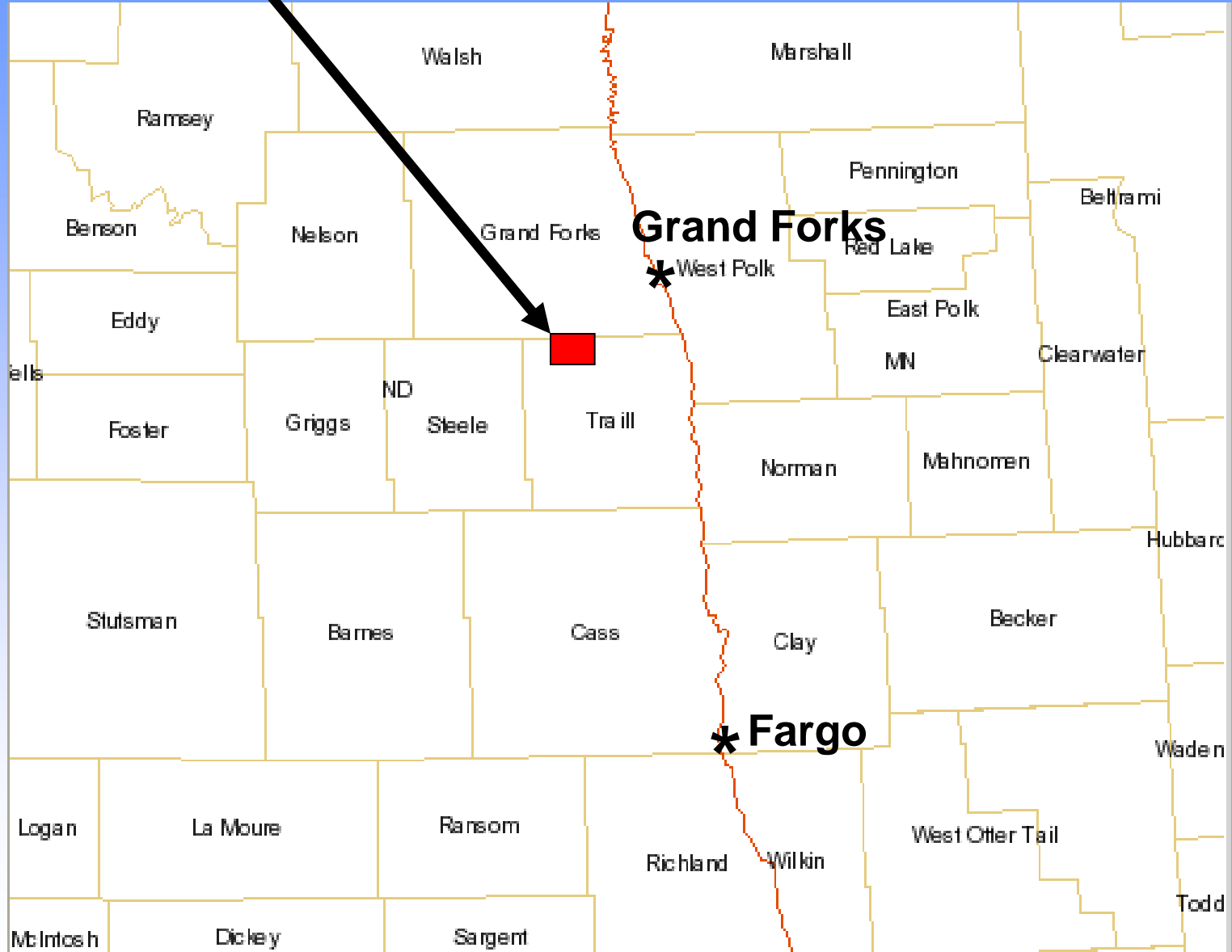
Sodic Soil Reclamation Demonstration Project

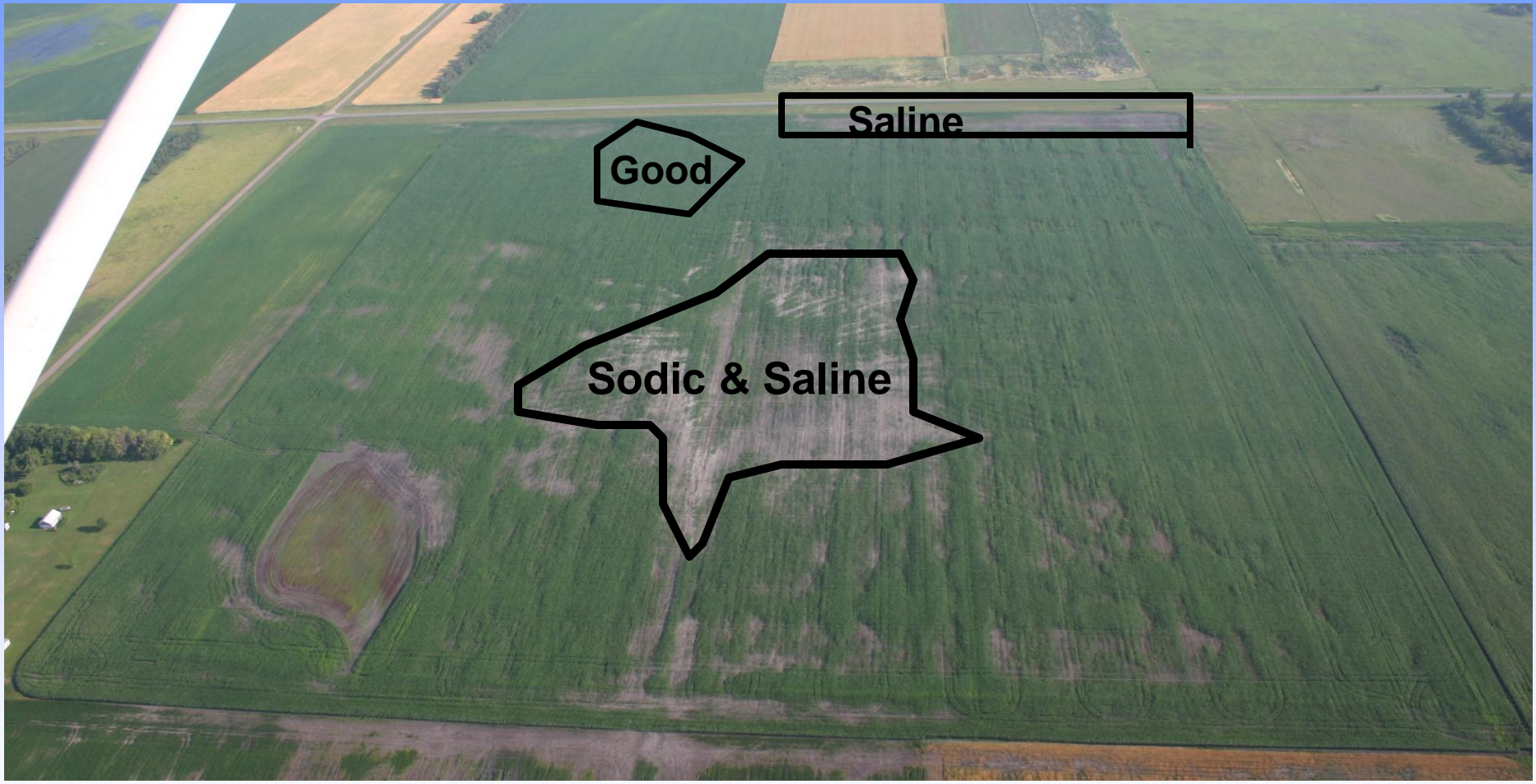
2008 to ?????

**Farmer: Mike Kozojed
Consultant: Greg Riedman**



Sodic Soil Demonstration Project



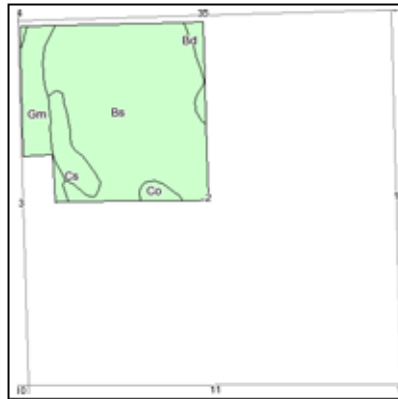
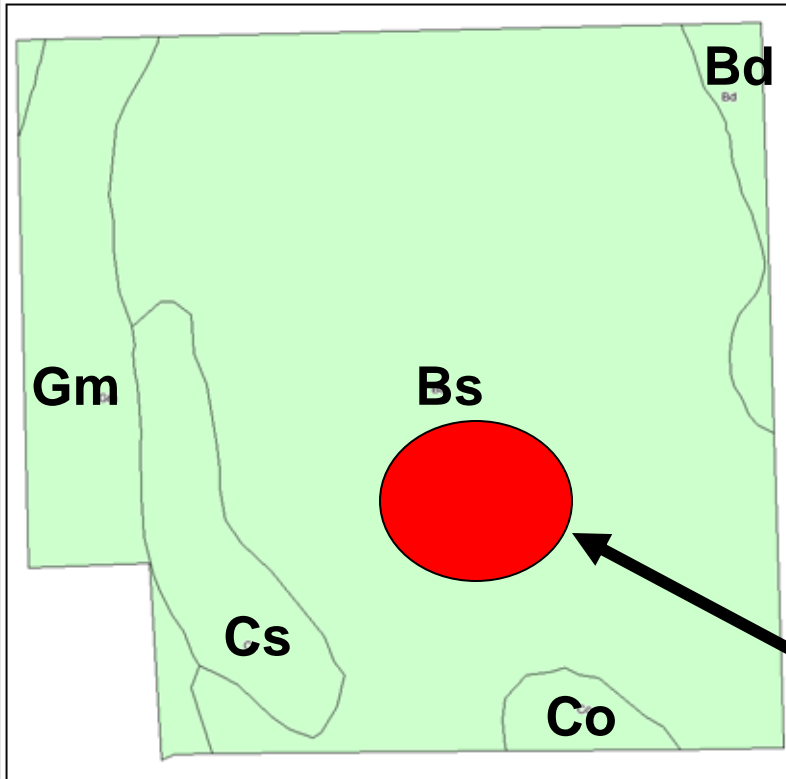


Good

Saline

Sodic & Saline

Soils Map



State: North Dakota
 County: Traill
 Location: 002-146N-051W
 Township: Norway
 Acres: 142
 Date: 12/7/2009

**No Sodic/saline
 Soil on the map?**

Fsa borders provided by the Farm Service Agency as of May 23, 2008.
 Soils data provided by USDA and NRCS.



Maps provided by:



©AgriData, Inc 2008
 www.AgrDataInc.com

Code	Soil Description	Acres	Percent of field	Non-Irr Class	Irr Class	Productivity Index
Bs	Bearden and Glyndon silt loams	107.5	75.7%	Ile		95
Gm	Glyndon silt loam	16.9	11.9%	Ile		94
Cs	Colvin silt loam, saline	10.6	7.4%	III _s		42
Bd	Bearden silt loam, saline	3.8	2.7%	III _s		57
Co	Colvin silt loam	2.8	2.0%	II _w		69
HmB	Hecla-Maddock sandy loams, 2 to 6 percent slopes	0.4	0.3%	III _e	Ile	56
Weighted Average						89.3

Reclamation for Sodic Soil must include improved drainage

Tile drainage installed in 2007







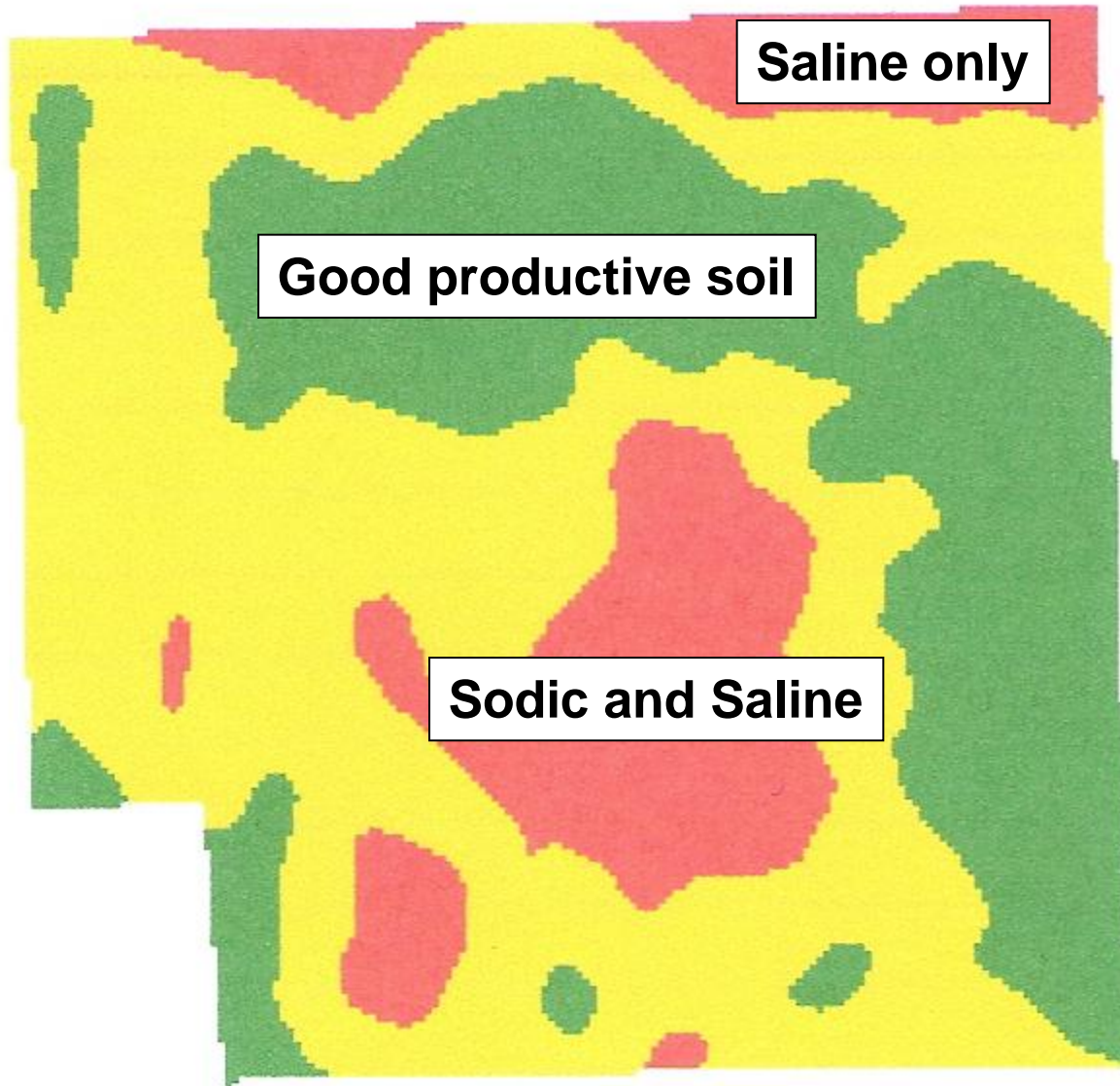
An aerial photograph of a rural landscape with various agricultural fields in shades of green and brown. A white rectangular box with a black border is overlaid on the image, containing the title and a list of crop rotation details.

Crop Rotation

- 2007 Corn
- 2008 Corn
- 2009 Prevent Plant
- 2010 Winter wheat

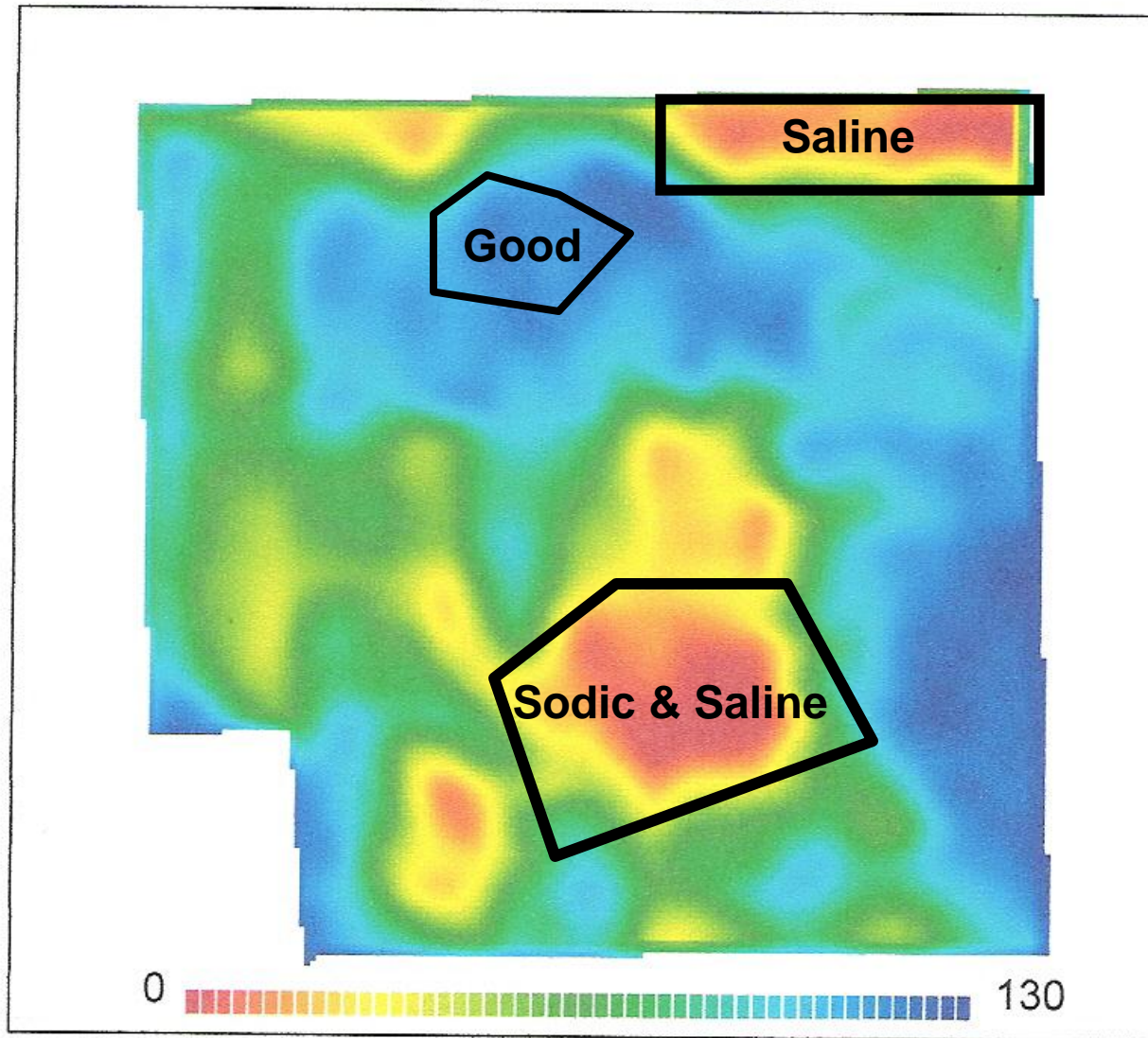
Management Zone Map

Imagery Date: 07/19/2007



Virtual Yield Image

Imagery Date: 07/19/2007



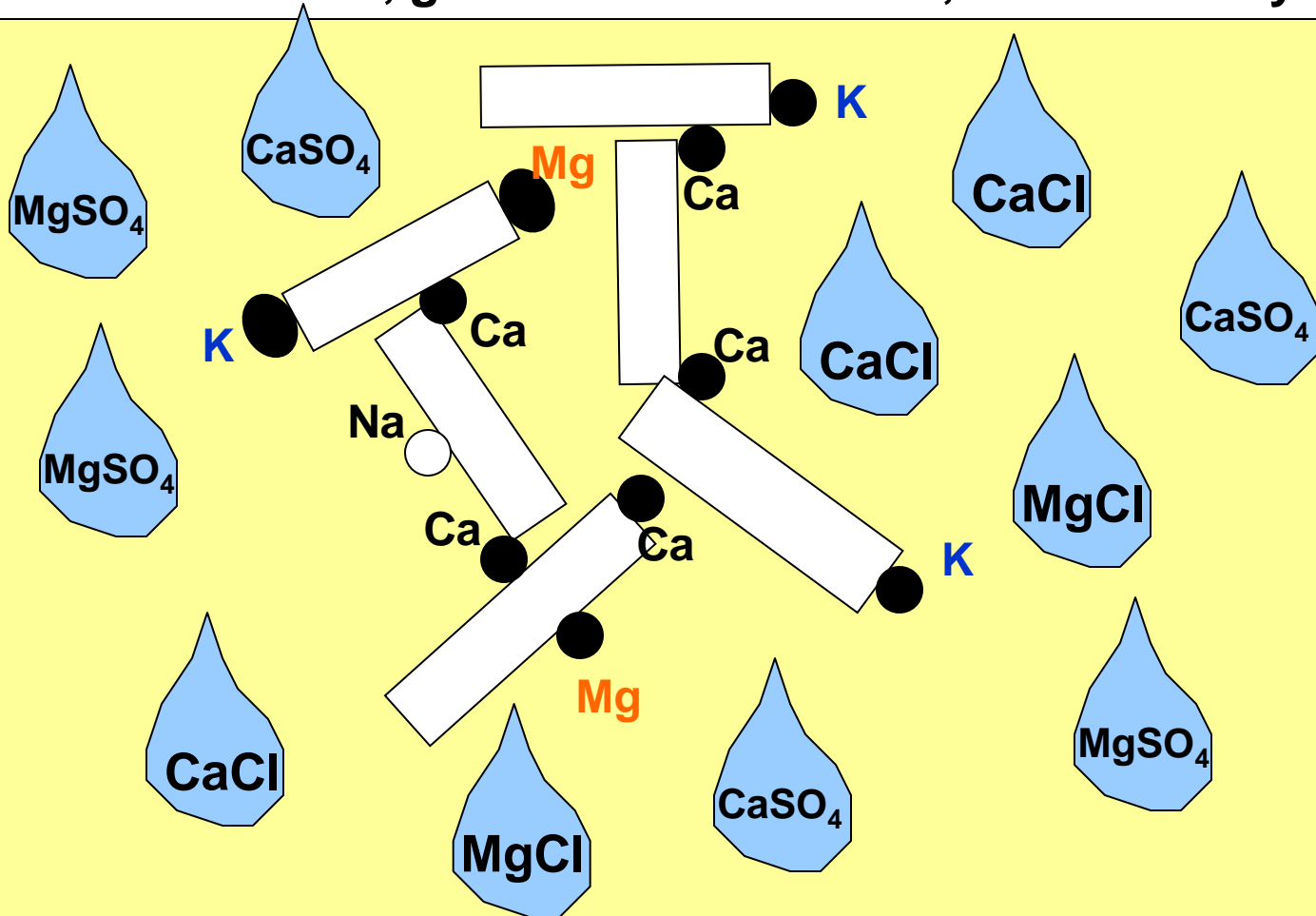
Average Yield: 76.4
Crop: Corn

Samples collected and Geo-referenced for future soil monitoring



**Saline Soils (salt greater than 2.0 mmhos/cm)
Sodium is low (less than 4%)**

Good structure, good water infiltration, soft when dry

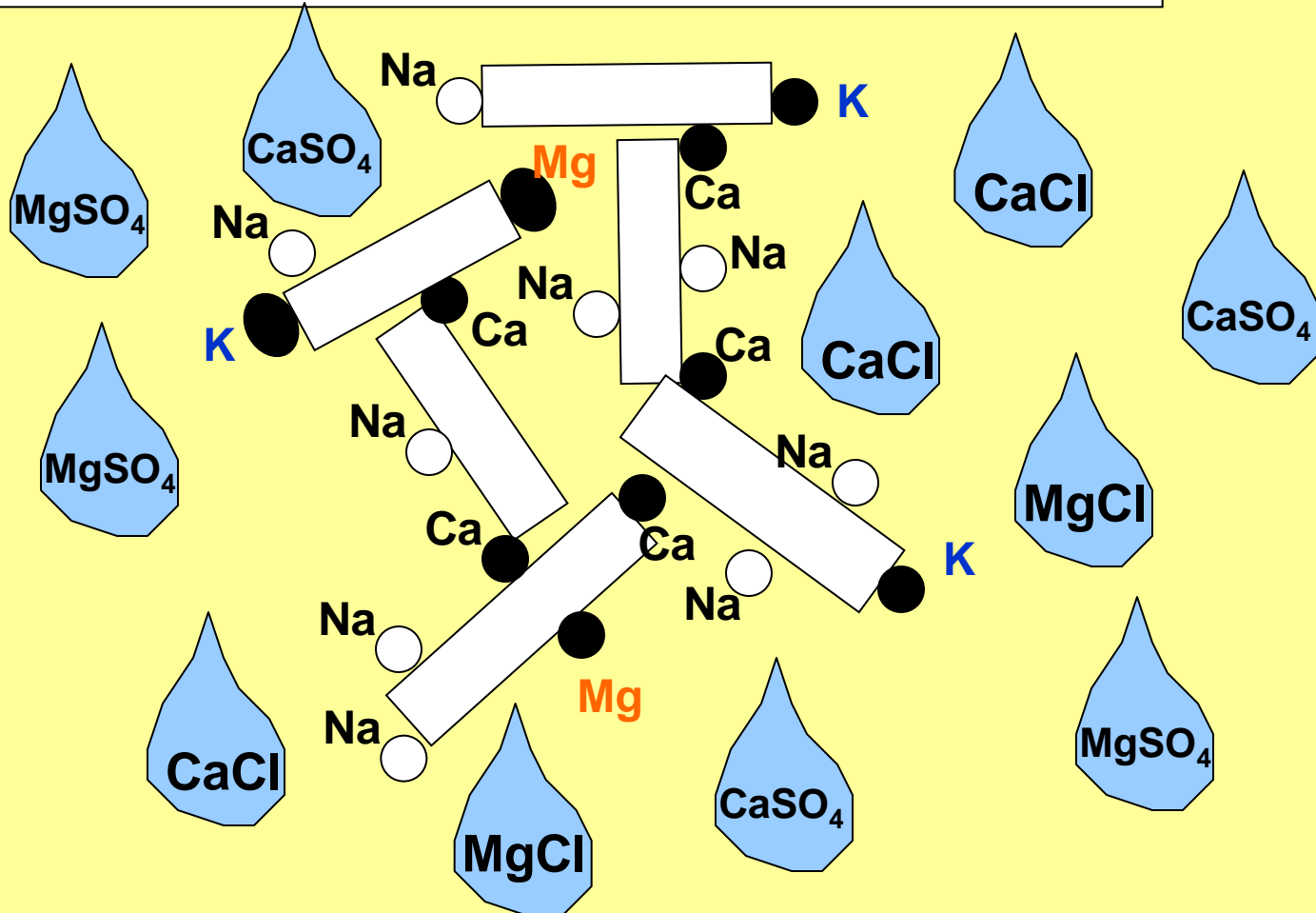


Osmotic affect caused by Salts hurt plant growth

Saline and Sodic Soil (Real Mess)

Salt greater than 2.0 mmhos/cm and Sodium is higher than 15%

Fair soil structure due to calcium and magnesium salts
Fair water infiltration



Poor crop growth due to osmotic affect caused by salts and sodium ion affect

Normal productive Soil – Salts 0.5 mmhos/cm sodium 147 ppm



Water saturated and left to evaporate. Day 3 soil cracks open to allow for air flow and water Infiltration.

Normal productive Soil – Salts 0.5 mmhos/cm sodium 147 ppm



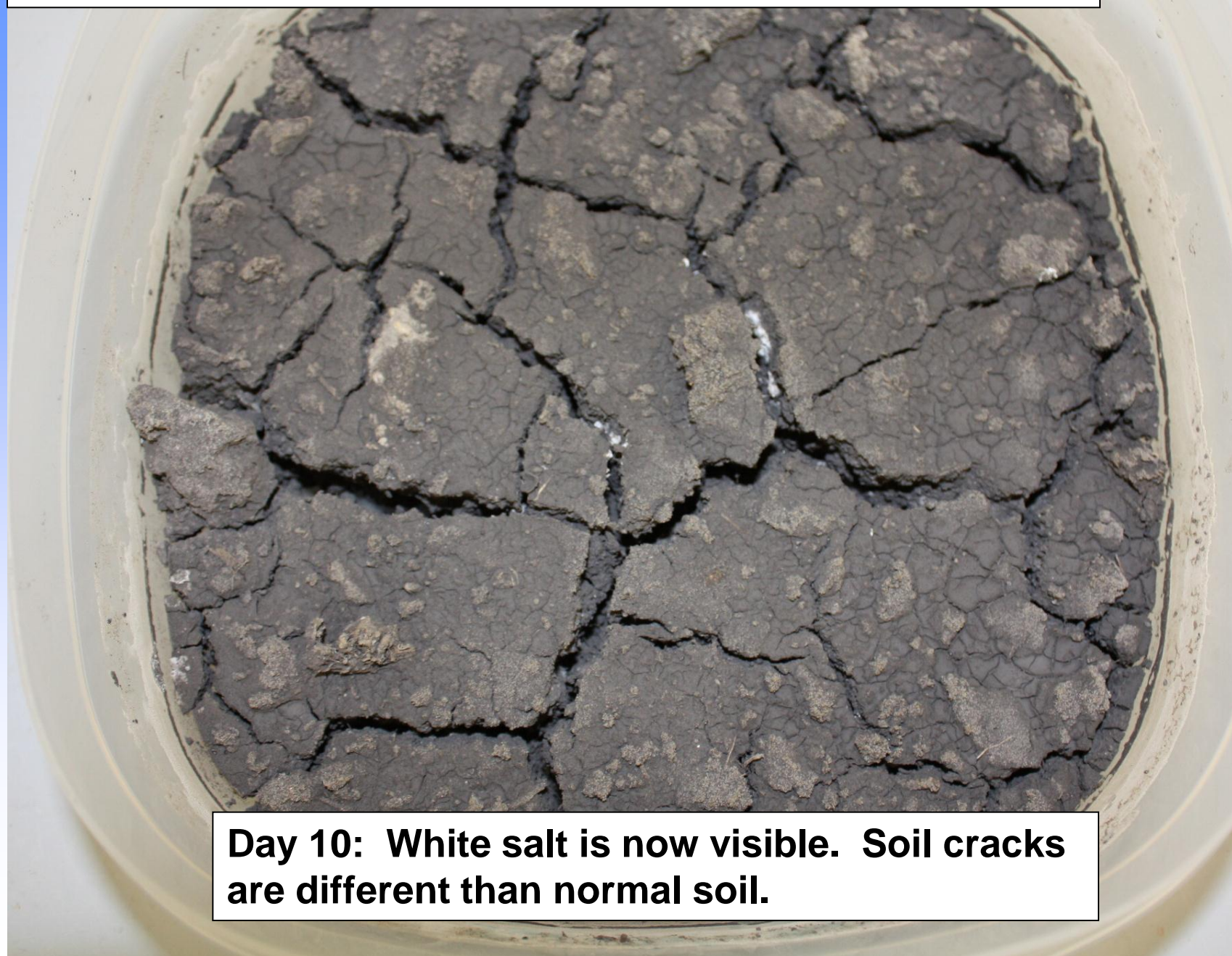
Day 10: Soil cracks open to allow for air flow and water.

Sodic/Saline Soil – Salts 2.7 mmhos/cm sodium 1500 ppm



**Water saturated and left to evaporate. Day 3
No cracks, surface still sealed.**

Sodic/Saline Soil – Salts 2.7 mmhos/cm sodium 1500 ppm



Day 10: White salt is now visible. Soil cracks are different than normal soil.

Routine Soil Analysis

Sample ID	Sample Date	Soil pH	Sodium Screening test	% Sodium	Soluble Salts Screening test
Sodic/saline	3-08	----	1623 ppm	14.0%	
Sodic/saline	5-09	8.5	1461 ppm	14.0%	2.2 mmhos/cm
Sodic/saline	8-09	8.8	1555 ppm	16.0%	2.7 mmhos/cm
Normal productive Soil	8-09	8.2	147 ppm	1.7%	0.48

Sodium screening test – ammonium acetate

Soluble salts – Routine/Screening test – 1:1 soil to water method

Special Soil Analysis

Sodic/Saline Area

Date	SAR Sodium Adsorption Ratio	Soluble Salt	Soluble Salt
	Saturated Paste Method	Saturated Past Method	Routine/Screening Method 1:1 soil to water
Nov 2009	10.0	5.16 mmhos/cm	2.28 mmhos/cm

Saturated Paste Method takes soil texture into account to get a better Idea of the affect on salinity on plant growth on that soil. Saturated Paste method allows for better estimation of Gypsum needs

How much Gypsum to apply?

		Current	Desired	Na to	Amendment - 6 " Soil		
	soil	%	%	be replaced	Gypsum		
<u>Sample ID</u>	<u>CEC</u>	<u>Sodium</u>	<u>Sodium</u>	<u>(cmol/kg)</u>	<u>Tons/acre</u>		
11383018		15	1	4.361	7.50		

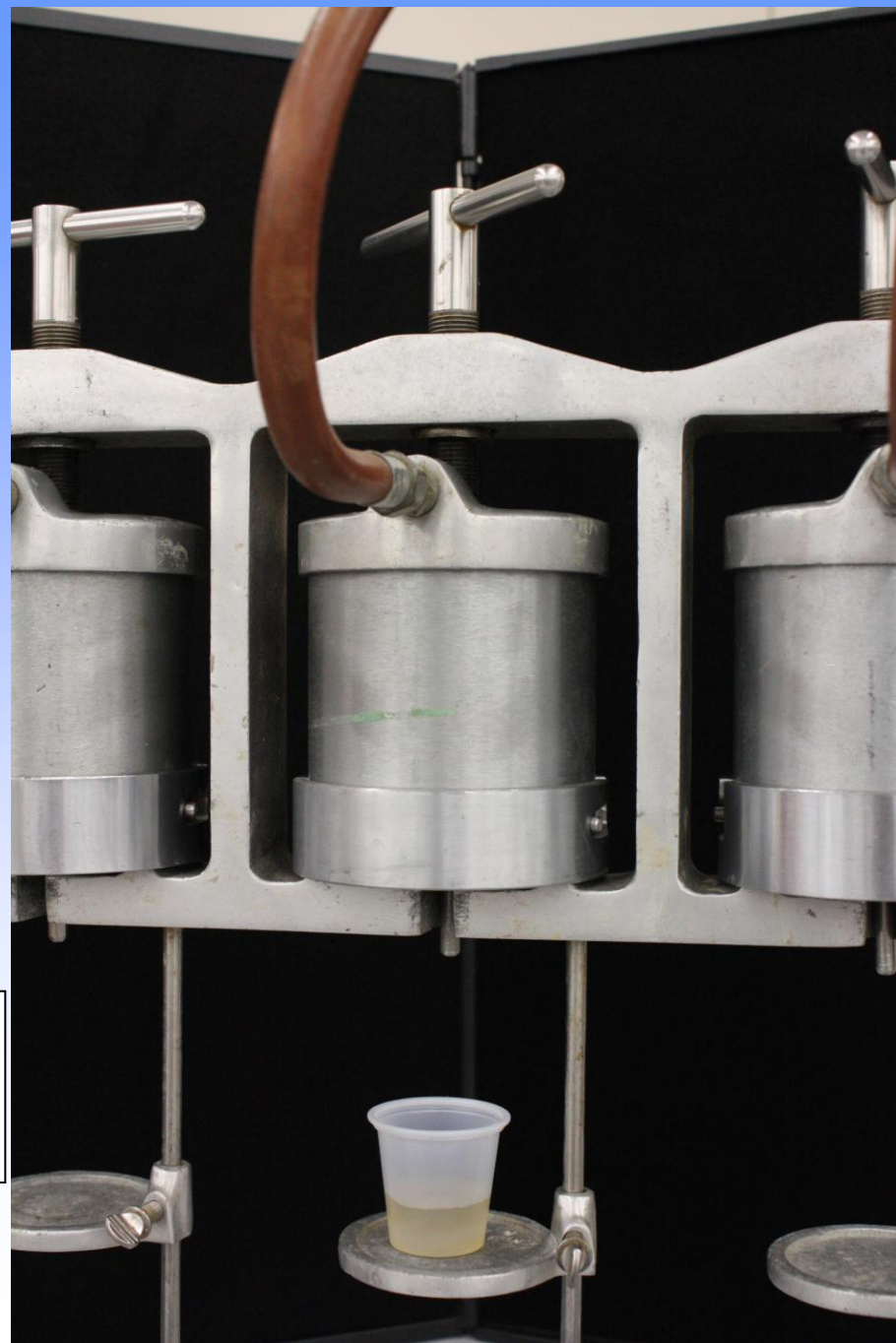
AGVISE Soil Scientists will help with calculation!

Saturated paste Method

Make a soil saturated paste and then extract the free water with air pressure

Saturated paste salt values are about 2 x the routine salt test runs by commercial soil labs

**Loam soil texture:
Routine/screening salt = 1.0 mmhos/cm
Saturated paste salt = 2.0 mmhos/cm**



Amending Sodic Soils

- Gypsum – CaSO_4
 - Most commonly used calcium amendment
 - Relatively inexpensive
 - Common rates are tons/acre



Amending Sodict Soils

- Calcium replaces Sodium on the soil
 - Calcium forms a stronger bond than sodium
- Sodium will be leached out of the soil
- Soil structure will be improved
 - Water infiltration is improved (less crusting)
 - Water percolation through the soil profile is improved
 - Toxic affects of sodium on plant growth removed

ProfitZ Application Map

1000 lb/a gypsum
Spring 2008

Saline only

1000 lb/a gypsum
Fall 2009

4000 lb/a gypsum
Spring 2008

Sodic/Saline

Gypsum cost \$125/ton

6000 lb/a gypsum
fall of 2009

0 100ft

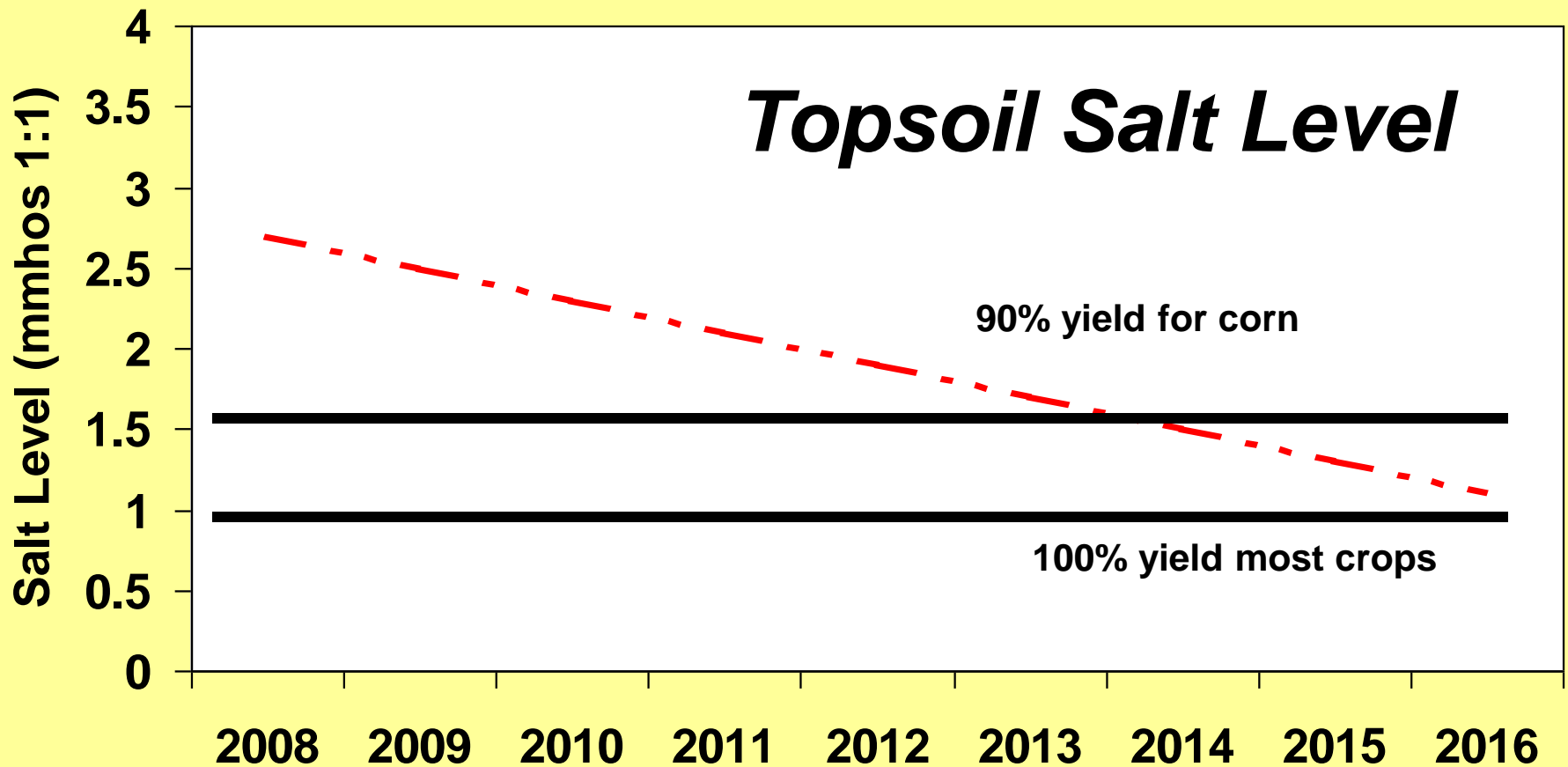
Farm : Mike Kozojed	Target Rate(Mass)
Field : Sodic Area	(lb/ac)
Year : 2008	1000.0 (14.4 ac)
Product : Gypsum	0.0 (124.8 ac)
Area : 138.7 ac	
Total Amount : 14316.5 lb	
Average Rate : 103.2 lb/ac	

4 trips a 1000 lb/a with applicator

What is expected for this field?

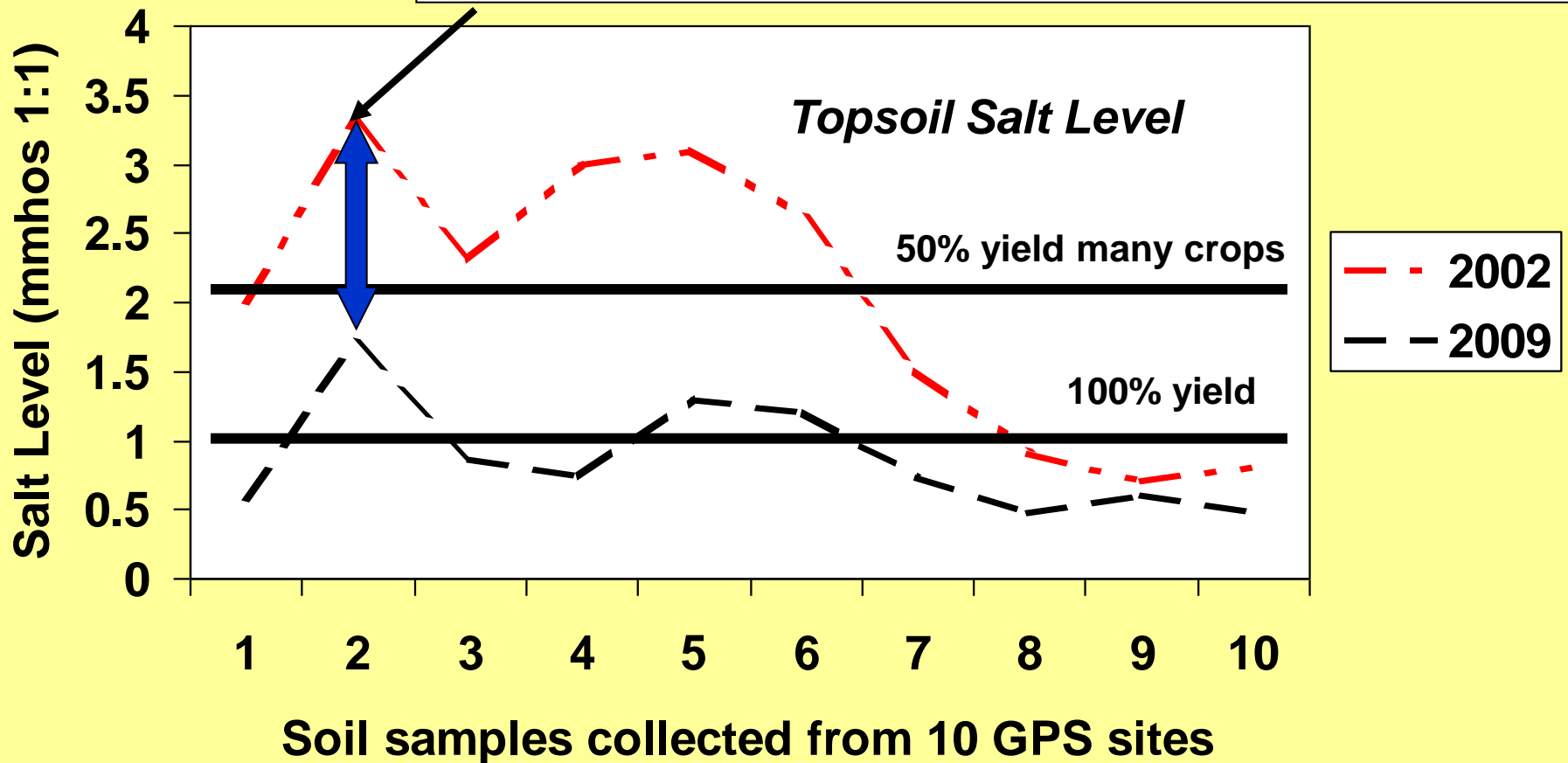
- Sodic and Saline area
 - Tile drainage will remove salt from the topsoil first improving crop germination and yield.
 - Sodium will be replaced by the calcium from the gypsum. Sodium will be leached from the soil. Water infiltration will be improved
- Saline areas
 - Tile drainage will remove salt from the topsoil first improving germination and production.
- Good productive soil areas
 - Tile drainage will allow earlier planting and reduce losses of N due to denitrification

Sodic and Saline Area Future Salinity Reductions



AGVISE Tile Drainage Demo Project 2002-2009

Salt decreased from 3.5 mmhos/cm to 1.7 in 7 years

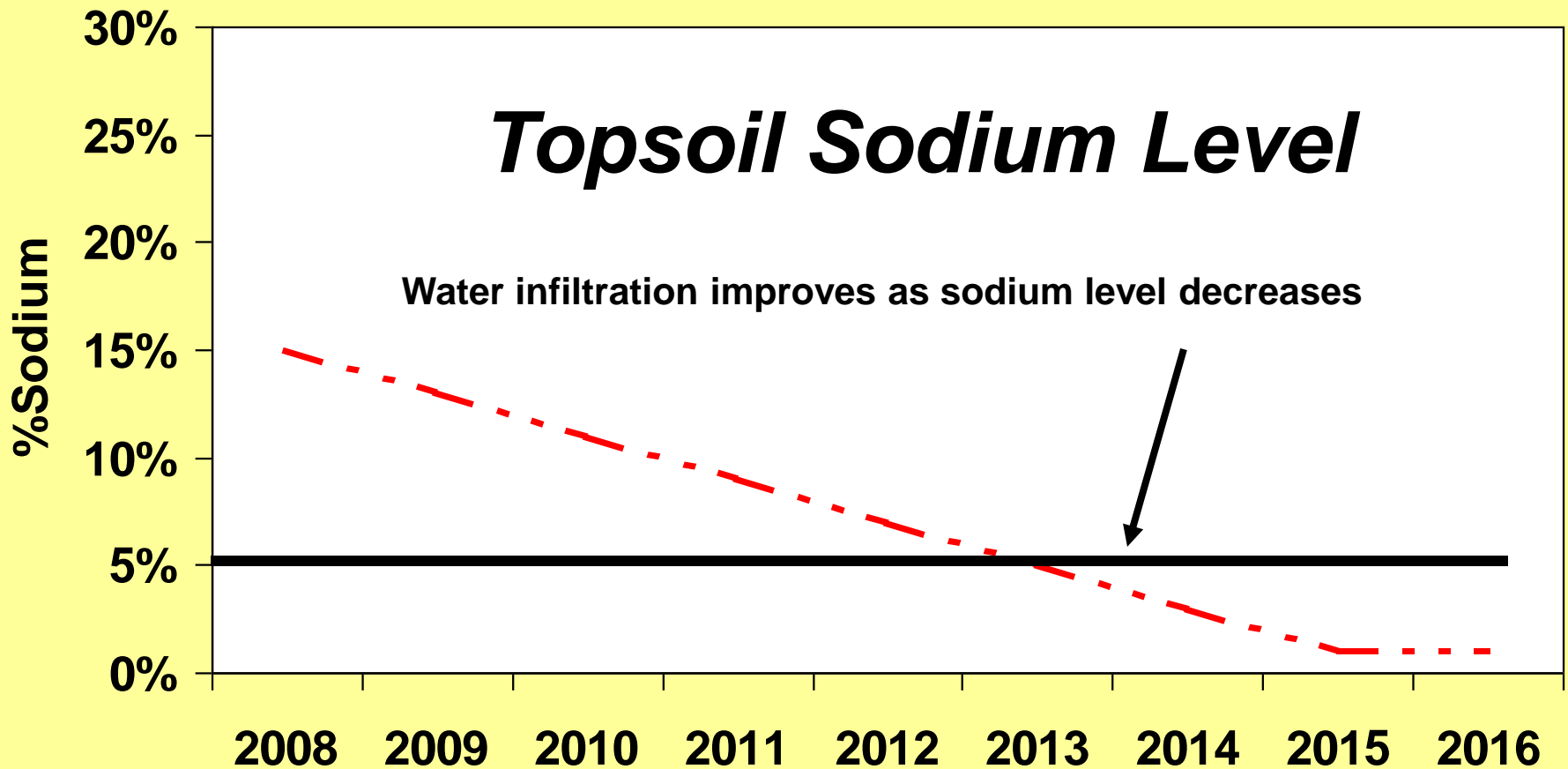


Salt Tolerance of Field Crops

(Based on 1:1 common Salt Method)

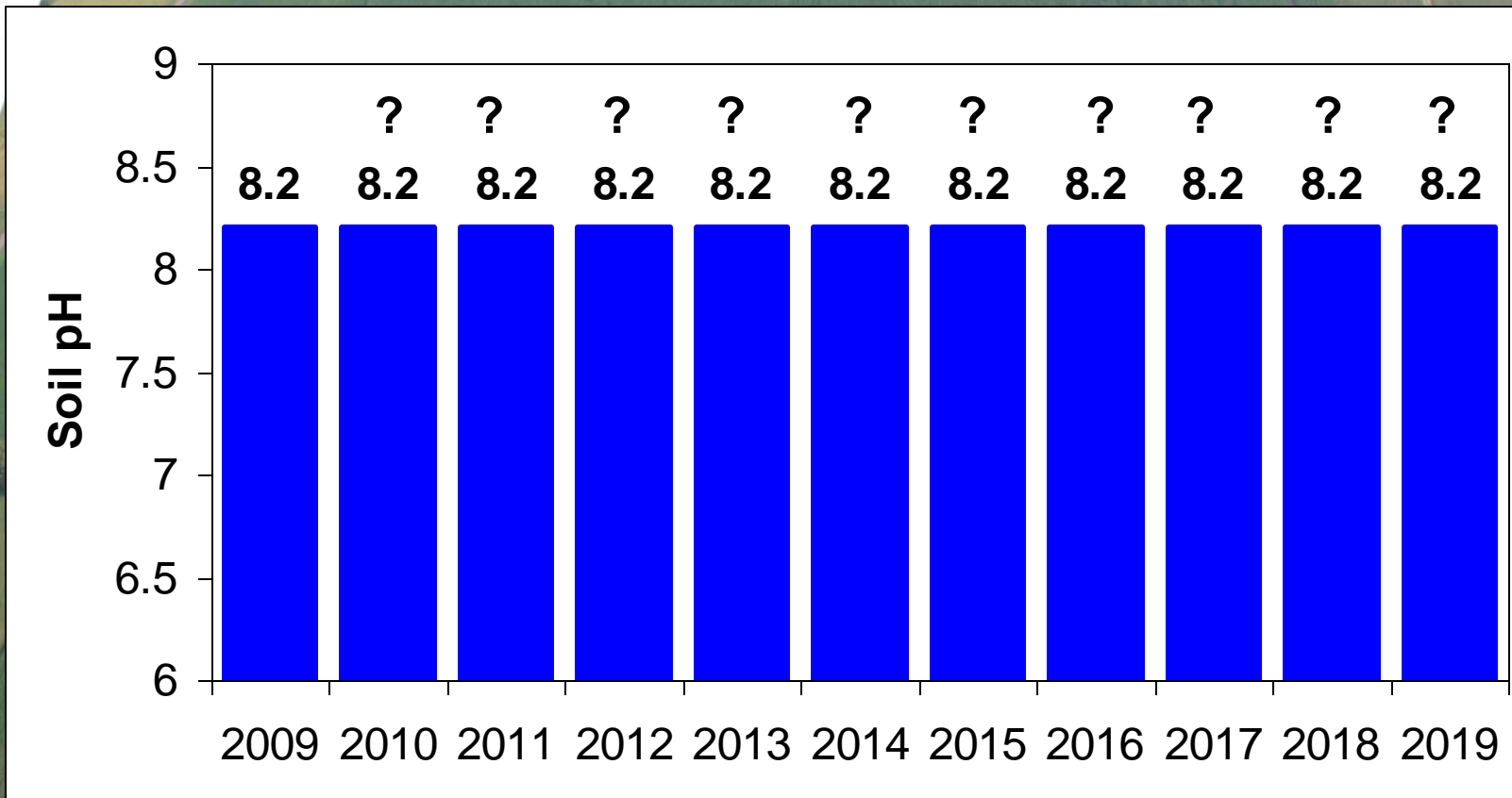
Crop	Salt Level 100% Yield	Salt Level 75% Yield	Salt Level 50% Yield
Barley	1.7	2.7	3.4
Sugarbeets	1.6	2.6	3.3
Corn	1.2	1.5	2.5
Wheat	1.0	1.7	2.3
Flax	.9	1.3	2.0
Canola	.9	1.3	2.0
Soybeans	.8	1.2	1.8
Potatoes	.8	1.2	1.8
Edible Beans	.6	1.1	1.6

Sodic and Saline Area Future Sodium Reductions



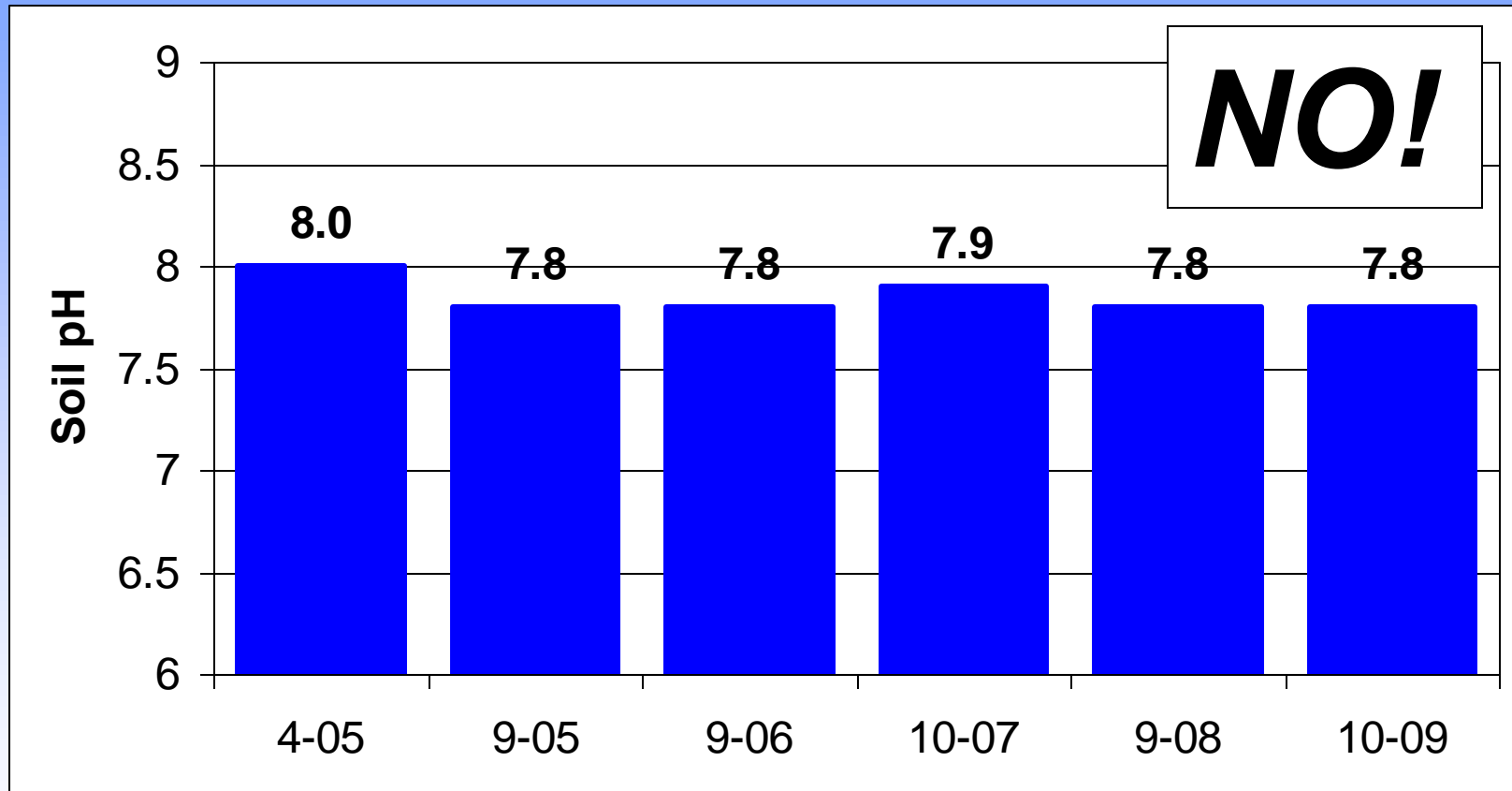
Will Gypsum Decrease Soil pH? In saline area area?

NO!



Does Gypsum Decrease Soil pH?

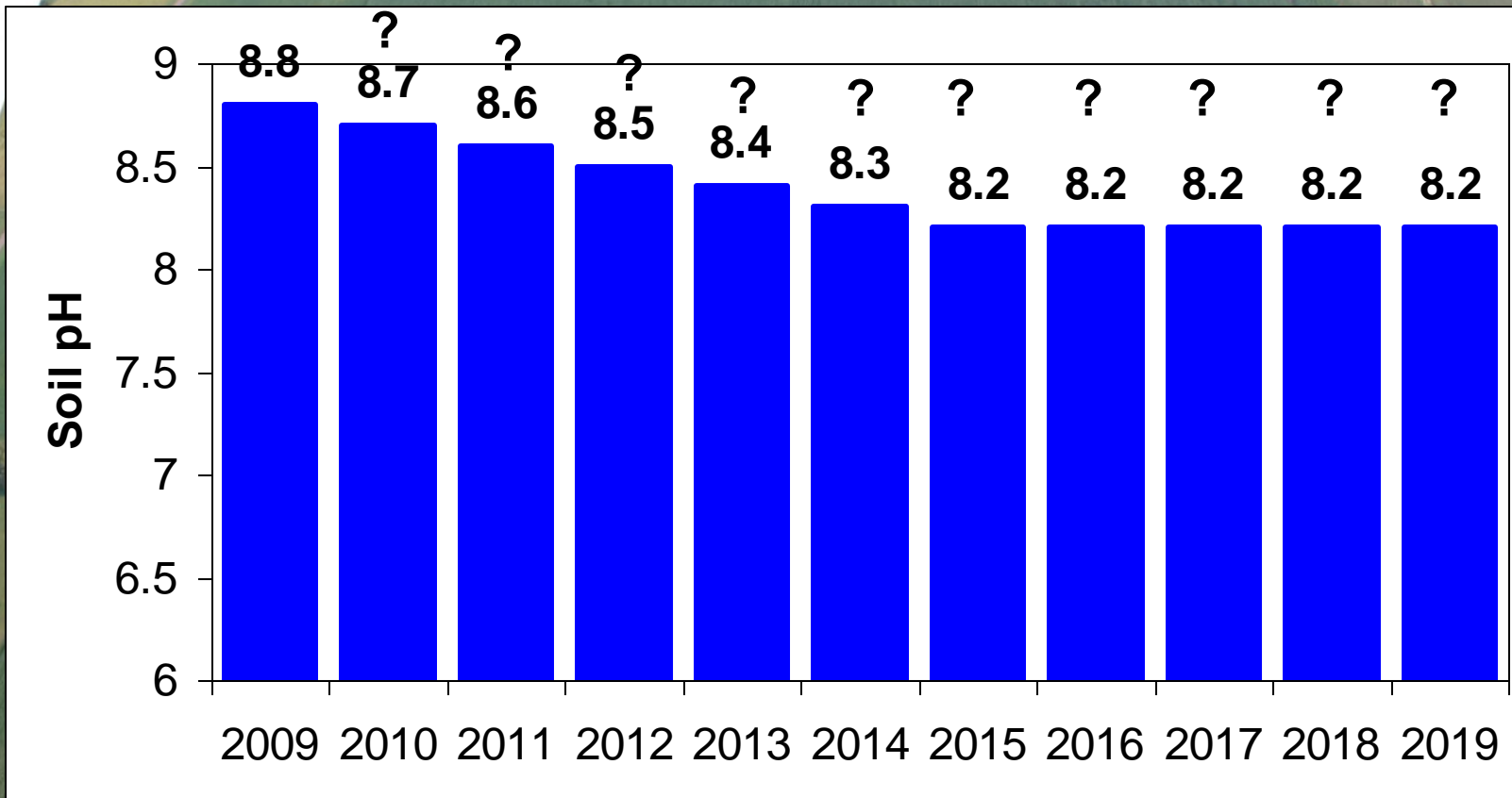
5000 lb/a Gypsum applied in 2005



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

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

*Will Gypsum Decrease Soil pH? In Sodic/Saline area? **Yes!***



Sodic Reclamation Project

- AGVISE will monitor improvements in salinity and sodium levels for many years
- Grower and consultant will track increases in crop productivity
- This project will educate all of us on how fast a sodic soil can be improved with tile drainage and gypsum in our region

Thank You!

- Please fill out reviews and suggest topics and speakers
- Make sure you have signed in and out on the CCA – CEU sheets
- Please have a safe ride home!

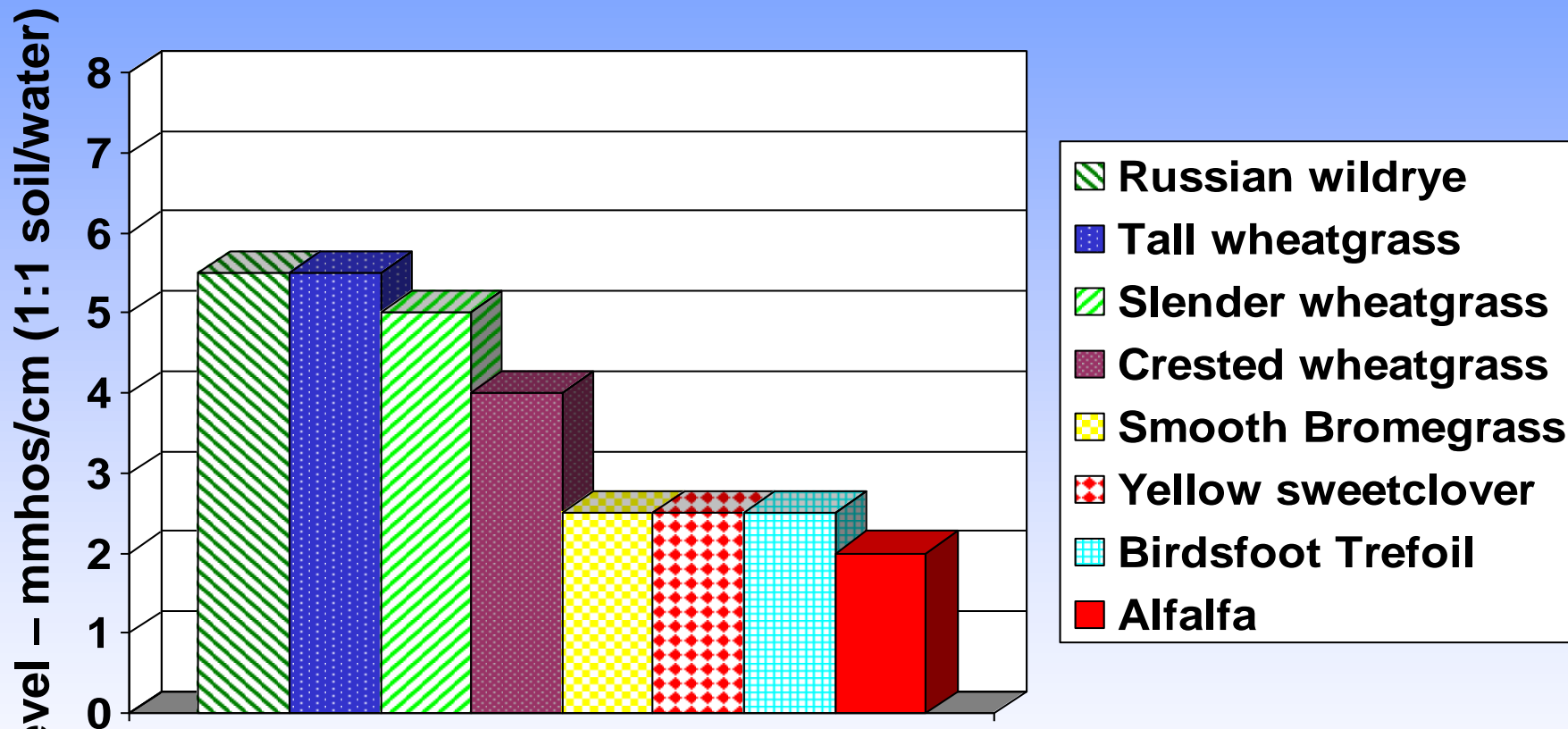
New Salt Tolerant Grasses

- AC Saltlander
 - Developed in Swift Current Saskatchewan by Dr. H. Steppuhn
 - Palatable and nutritious forage
 - Produces aggressively spreading rhizomes
 - 5-10 lb/a seeding rate
 - Similar to appearance to quack grass parent

Salt Tolerant Grasses

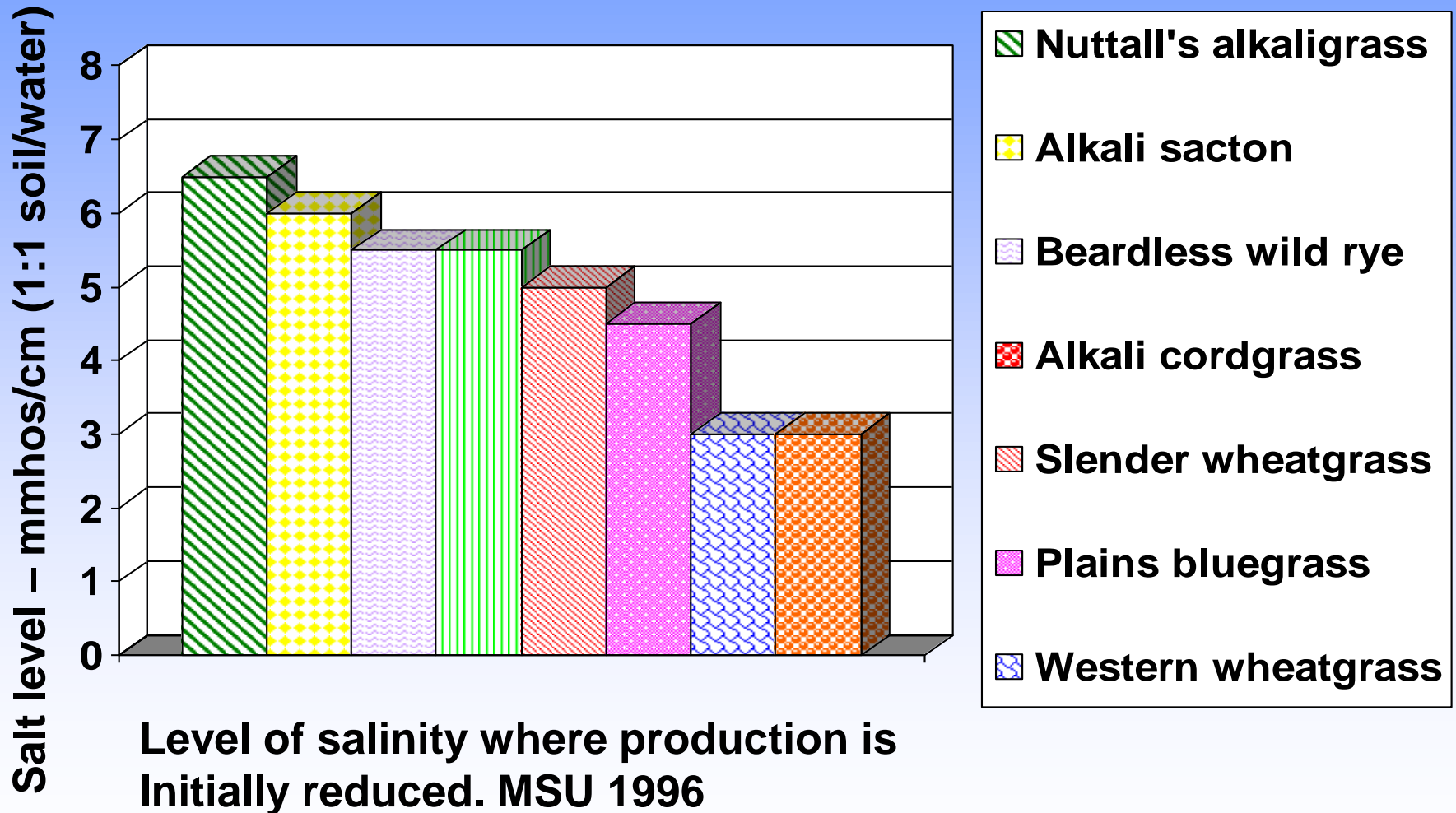
- NewHY
 - Released by ARS in 1989
 - Cross between quack grass and bluebunch grass
 - Palatable and nutritious forage
 - Produces aggressively spreading rhizomes
 - 7-10 lb/a/ seeding rate
 - Recovers quickly to grazing

Forages for Saline Soils



Level of salinity where production is Initially reduced. MSU 1996

Native Grasses for Saline Soils



Saline Soils

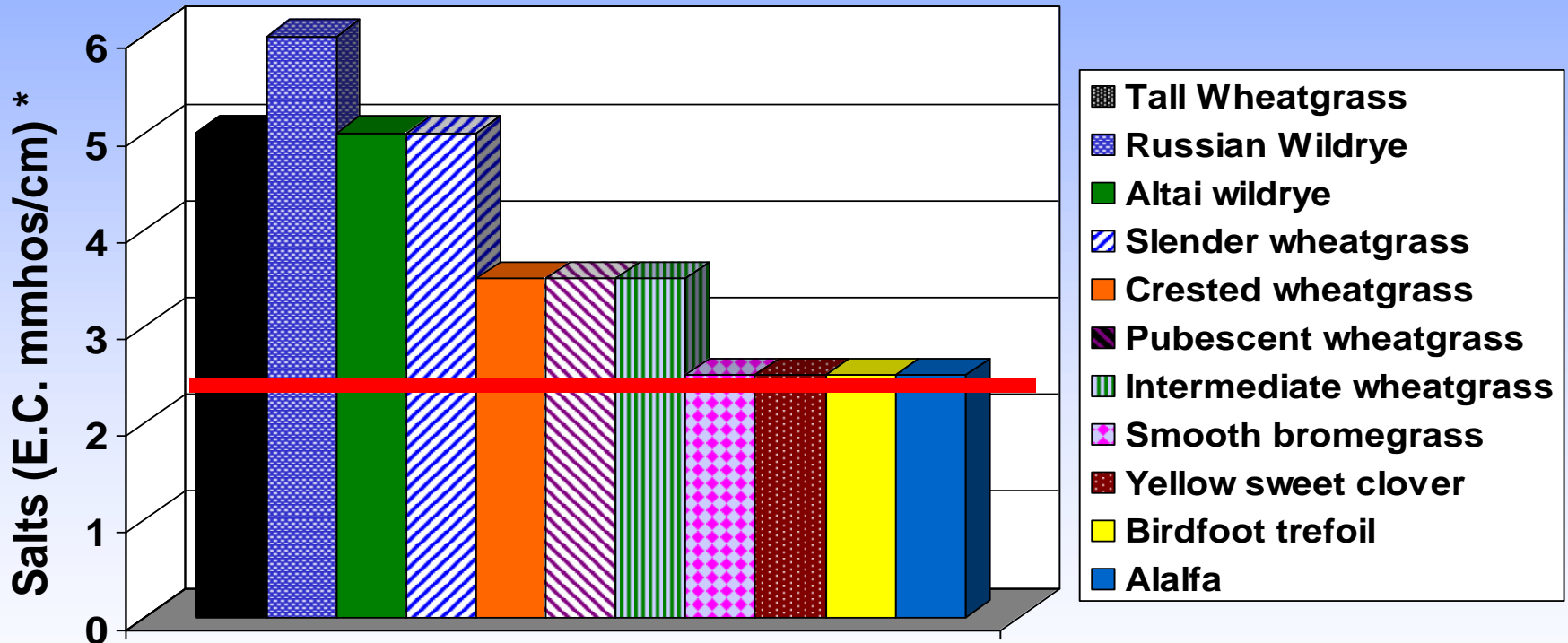
Crop	Rooting depth (feet)	Annual water use
Alfalfa	19	10.5"
Sainfoin	13	8.7"
Milkvetch	15	8.8"
Russian wildrye	10	8.0"
Tall wheatgrass	9	7.8"

Salt Tolerance

Forage Crops (1:1 common salt method)

(No spring flooding)

Compiled data from Salinity Laboratory, Riverside CA and U of Wyoming 1992



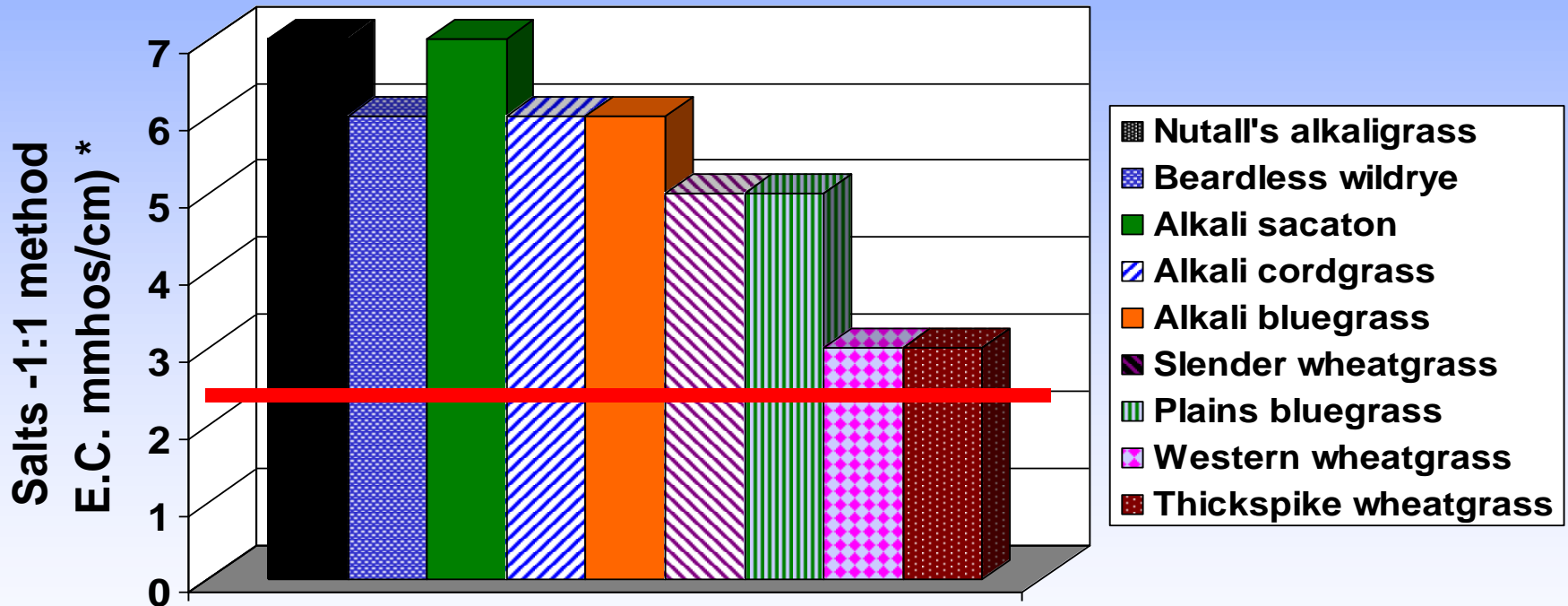
*Salt level where the productivity declines rapidly

Multiply value x 2.0 to estimate saturated paste method value for clay loam soil

Salt Tolerance

Native Forages (1:1 common salt method)

Compiled data from Salinity Laboratory, Riverside CA and U of Wyoming



*Salt level where the productivity declines rapidly

Multiply value x 2.0 to estimate saturated paste method value for clay loam soil

Forage Mix Seeding Rate

Soils with little or no spring flooding (less than 2 weeks)

Moderate Saline Soil: 1-3 mmhos/cm (common 1:1 salt method)

Forage Mixture

Seeding rate for hay or Pasture
lb/ac or kg/ha

Bromegrass + Russian wild ryegrass + alfalfa (Rambler)	4 + 4 + 4
Bromegrass + slender wheatgrass + alfalfa (Rambler)	4 + 4 + 4
Russian wild ryegrass + alfalfa	6 + 3
Altai wild ryegrass + alfalfa	10 + 3
Crested wheatgrass and alfalfa	7 + 3
Altai wild ryegrass	11
Slender wheatgrass + sweet clover (short term stands and not over 1 week of flooding)	8 + 6
Bromegrass + Russian wild ryegrass + slender wheatgrass	4 + 4 + 4

Forage Mix Seeding Rate

Soils with little or no spring flooding (less than 2 weeks)

Severe Saline Soil: 3-5 mmhos/cm (common 1:1 salt method)

Forage Mixture

Seeding Rate for hay or Pasture
lb/ac or kg/ha

Bromegrass + Russian wild ryegrass + slender wheatgrass	4 + 4 + 4
Altai wild ryegrass + alfalfa	10 + 3
Altai wild ryegrass	11
Tall wheatgrass (moist parts of seep areas)	12

Forage Mix Seeding Rate

Soils with little or no spring flooding (less than 2 weeks)

Very Severe Saline Soil: 5-7 mmhos/cm (common 1:1 salt method)

Forage Mixture

Seeding Rate for hay or Pasture
lb/ac or kg/ha

Russian wild ryegrass + slender wheatgrass	4 + 4
Altai wild ryegrass + alfalfa	10 + 3
Altai wild ryegrass	10
Tall wheatgrass (moist parts of seep areas)	12

Forage Mix Seeding Rate

Spring flooding (2-5 weeks)

Low Salinity Soil: 0.1 – 1.0 mmhos/cm (common 1:1 salt method)

Forage Mixture

Seeding rate for hay or Pasture
lb/ac or kg/ha

Reed Canarygrass + bromegrass	4 + 6
Reed Canarygrass + timothy	4 + 4
Timothy + bromegrass	4 + 6
Altai wild ryegrass + alfalfa	10 + 3
Altai wild ryegrass	11

Forage Mix Seeding Rate

Spring flooding (2-5 weeks)

Moderate Salinity Soil: 1.0-3.0 mmhos/cm (common 1:1 salt method)

Forage Mixture

Seeding rate for hay or Pasture
lb/ac or kg/ha

Reed Canarygrass + bromegrass	4 + 6
Reed Canarygrass + bromegrass + slender wheatgrass	4 + 4 + 6
Altai wild ryegrass	10 + 3

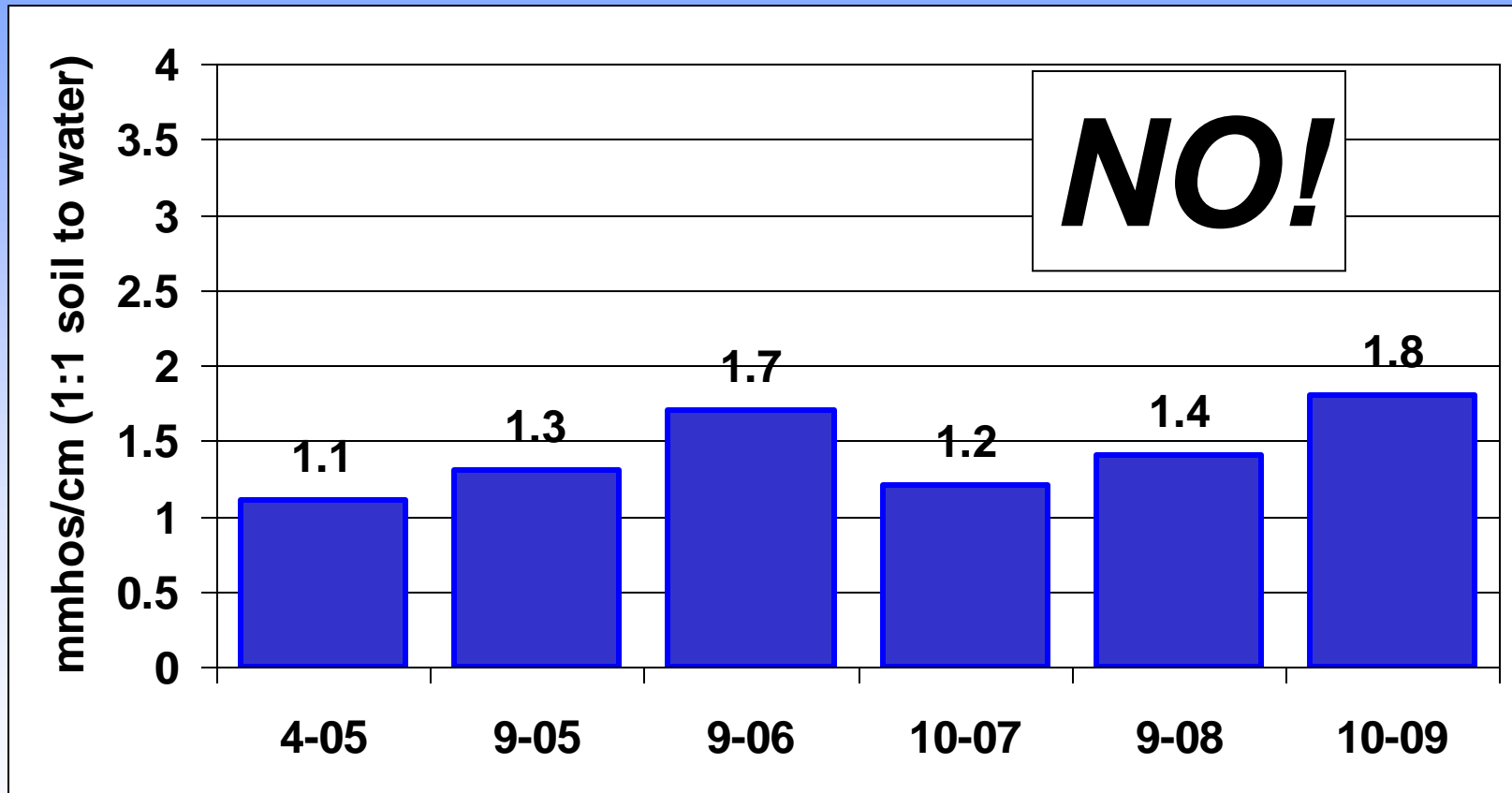
Approximate Yield Reduction due to salinity

Crop	100% Yield	75% Yield	50% Yield
Sugarbeets	1.7	2.7	3.4
Sunflower	1.7	2.7	3.4
Wheat	1.5	2.6	3.3
Corn	1.0	1.5	2.0
Flax	.9	1.3	2.0
Canola	.9	1.3	2.0
Soybeans	.8	1.2	1.8
Potatoes	.8	1.2	1.8
Dry beans	.6	1.1	1.6

Based on routine laboratory 1:1, soil to water method

Does Gypsum Reduce Soluble Salts?

5000 lb/a Gypsum Applied in 2005



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

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