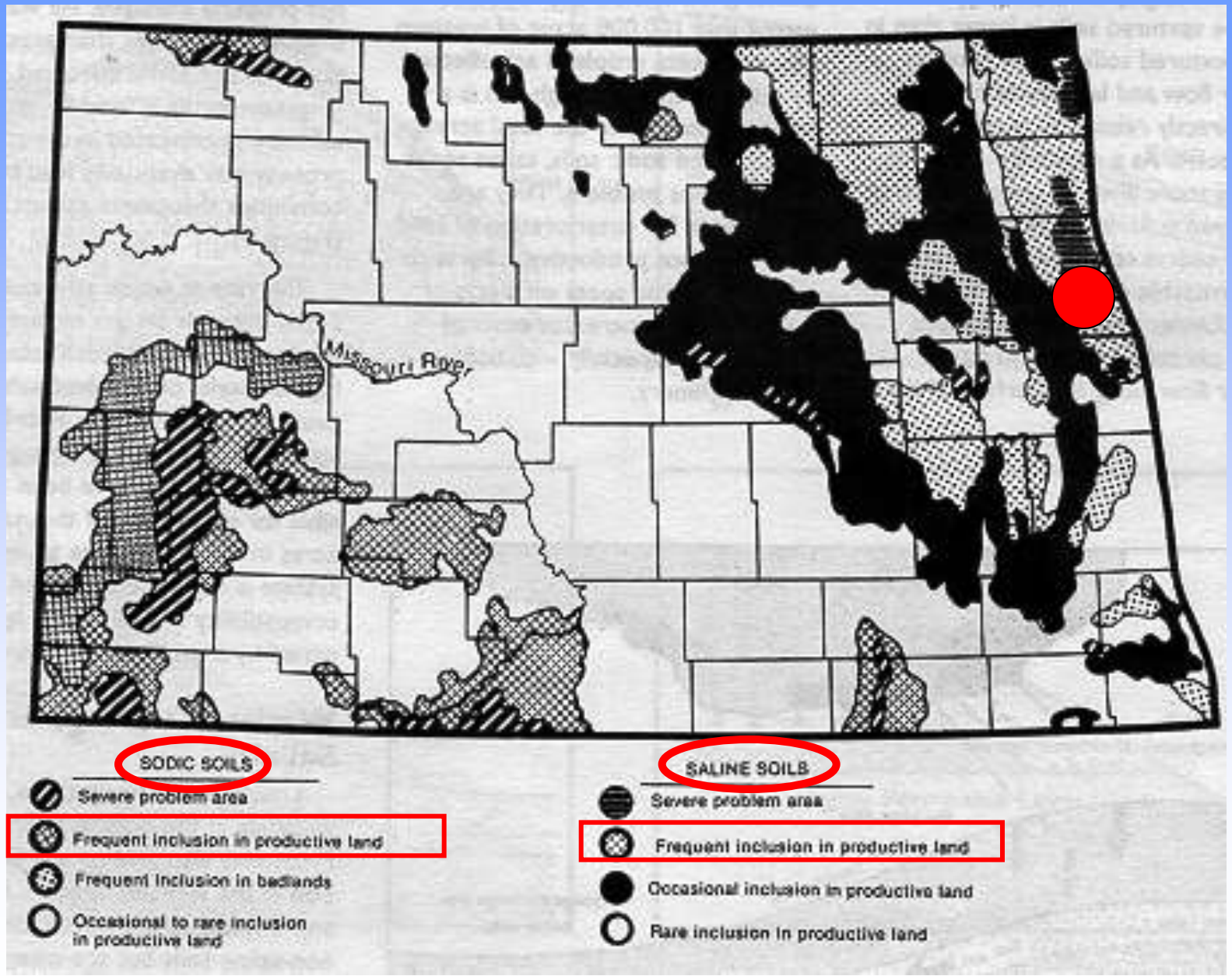
Sodic Soil – Gypsum Project Mayville, ND 2008 – 2011

- ***Sodic soil areas being recognized locally***
  - ***Tile drainage is revealing areas of sodic soils***
  - ***As the total soluble salt levels decreased by tile drainage, the sodium issue becomes more apparent***
  - ***Reclamation of the sodic areas with gypsum is necessary to improve productivity***

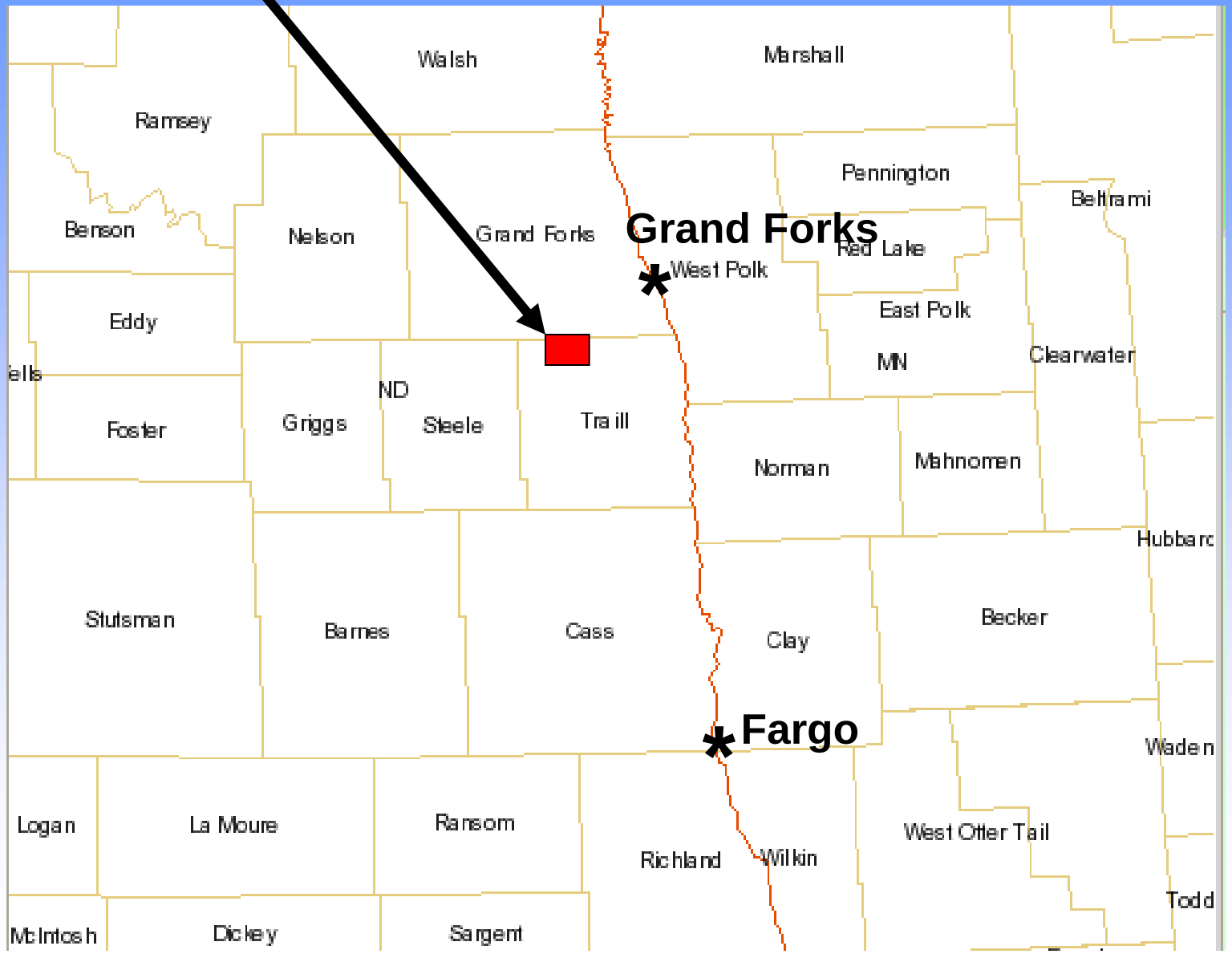
Sodic Soil – Gypsum Project Mayville, ND 2008 – 2011

- *Field Tile drained fall 2007*
- *Field zone soil tested - Fall 2007*
  - *14 acre zone with high sodium and salts*
    - *Sodium 1811 ppm (20% on exchange)*
    - *Total soluble salts = 2.7*
- *Gypsum application in Spring 2008 and 2009*

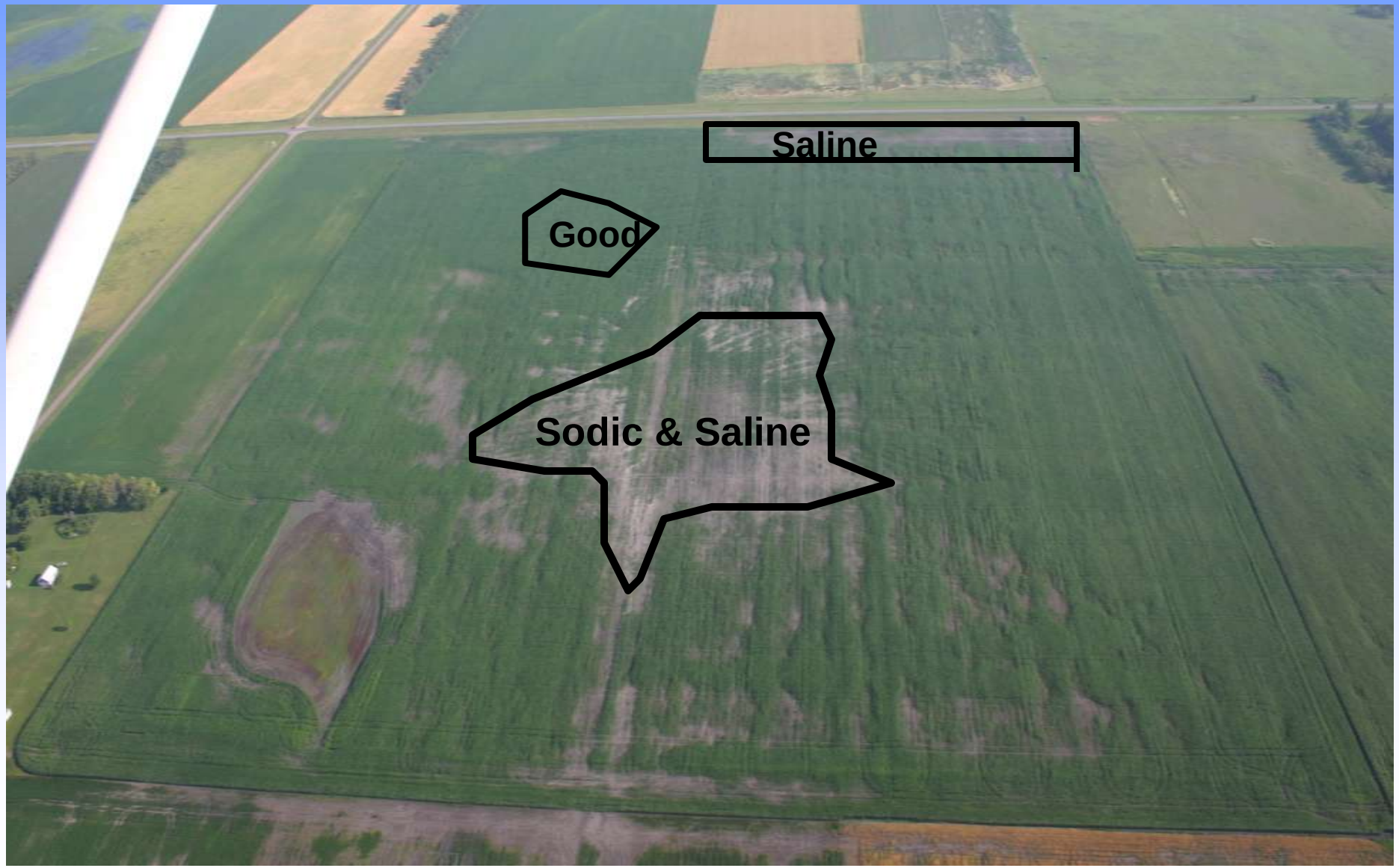
Saline & Sodic Soils in North Dakota



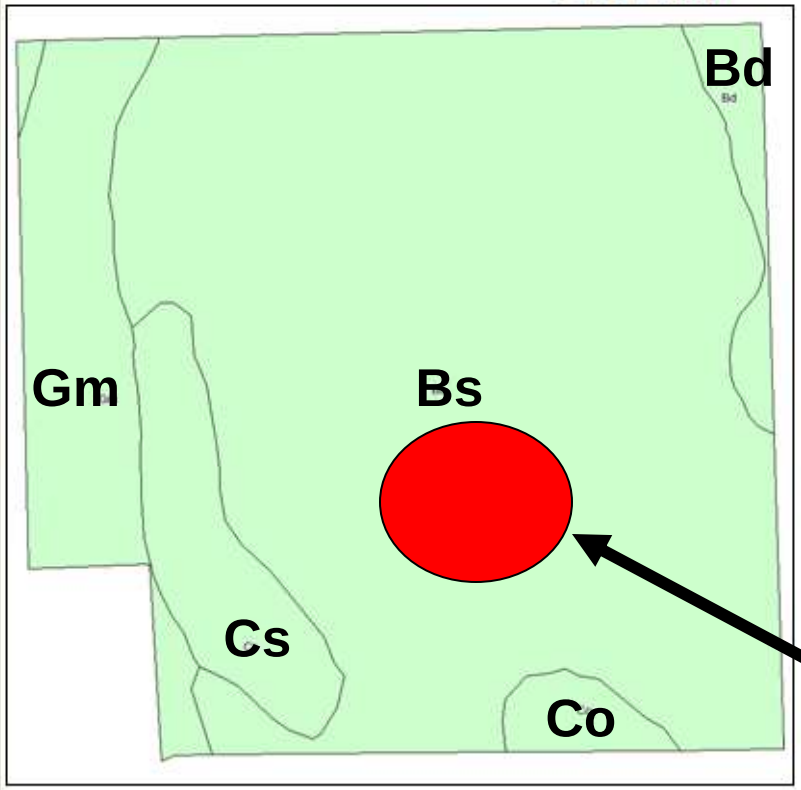
Sodic Soil Demonstration Project

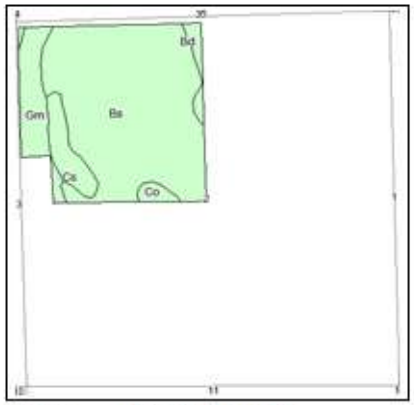


Greg Reidman – Consultant Mike Kozojed – Owner



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: surety

www.AgriDataInc.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%	IIe		95
Gm	Glyndon silt loam	16.9	11.9%	IIe		94
Cs	Colvin silt loam, saline	10.6	7.4%	IIIs		42
Bd	Bearden silt loam, saline	3.8	2.7%	IIIs		57
Co	Colvin silt loam	2.8	2.0%	IIw		69
HmB	Hecla-Maddock sandy loams, 2 to 6 percent slopes	0.4	0.3%	IIIe	IIe	56
					Weighted Average	89.3

Sodic/Gypsum Project (Long-Term Project)

- ***Point and Zone sampling each year (GPS)***
  - ***Field has been zone sampled each year***
    - ***Nutrient Trends over time***
      - ***Sodium***
      - ***Soluble salts***
      - ***pH***
      - ***Remaining nutrients***

Soil Productivity

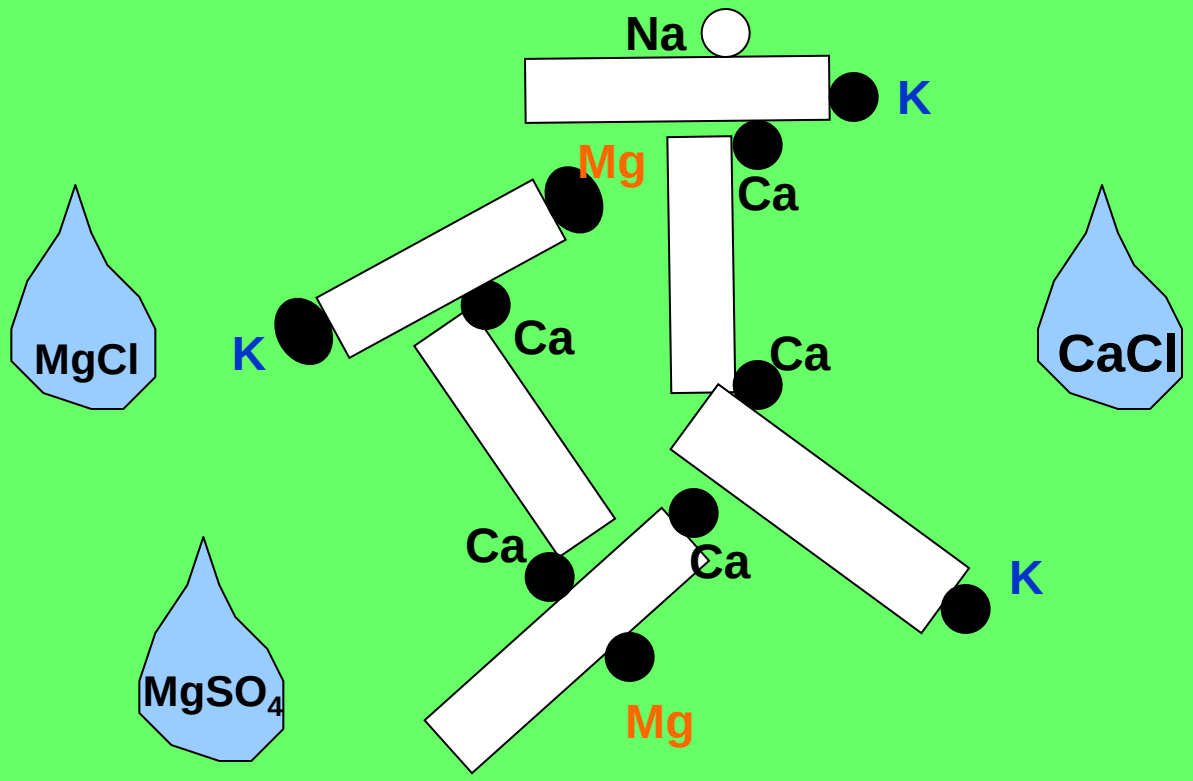
Based on Salinity and Sodium Level

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

Highly Productive Soil

Good structure, good water infiltration, soft when dry

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

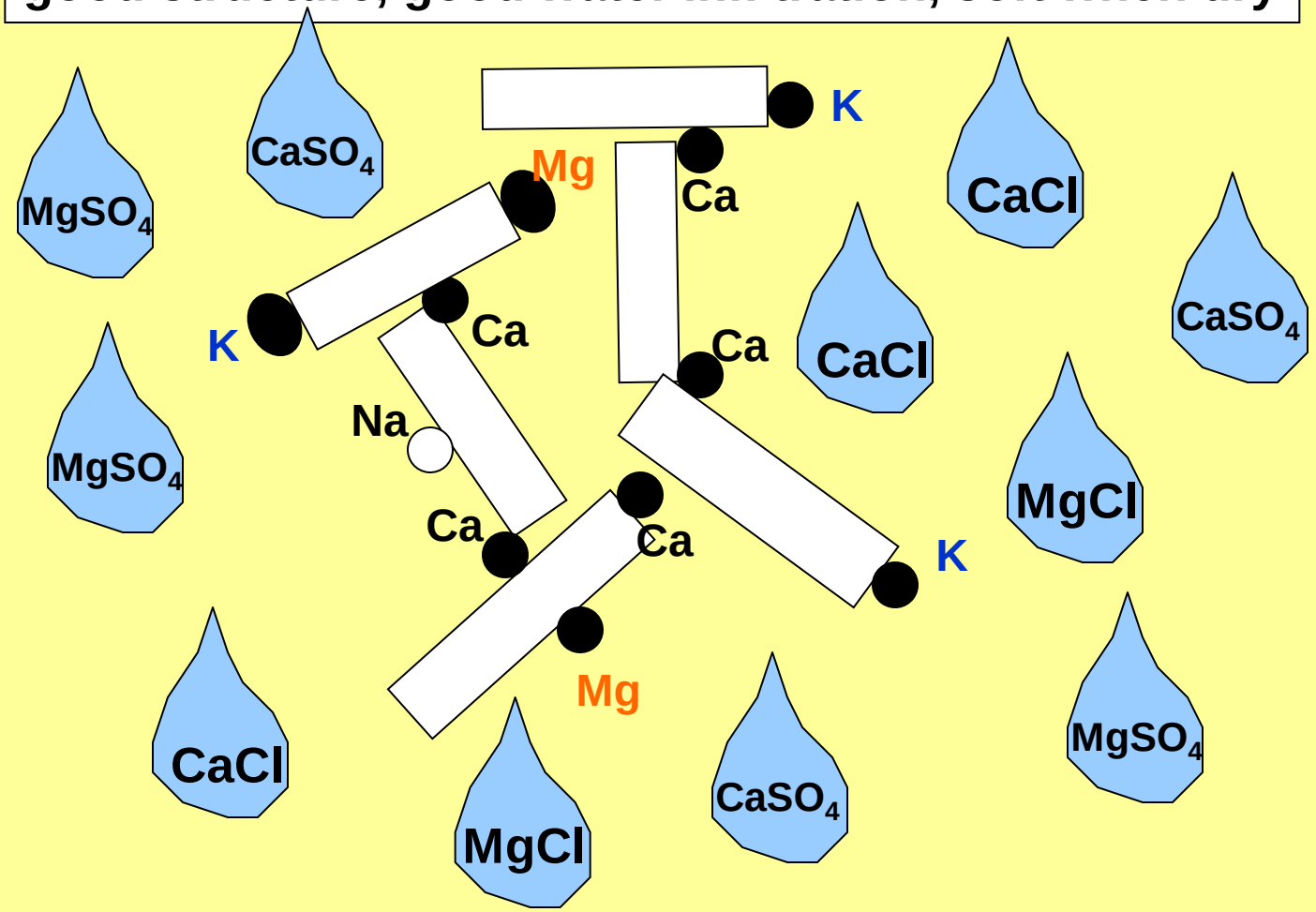


Saline (Salty) Soil

- 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, Canadian Prairies, 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



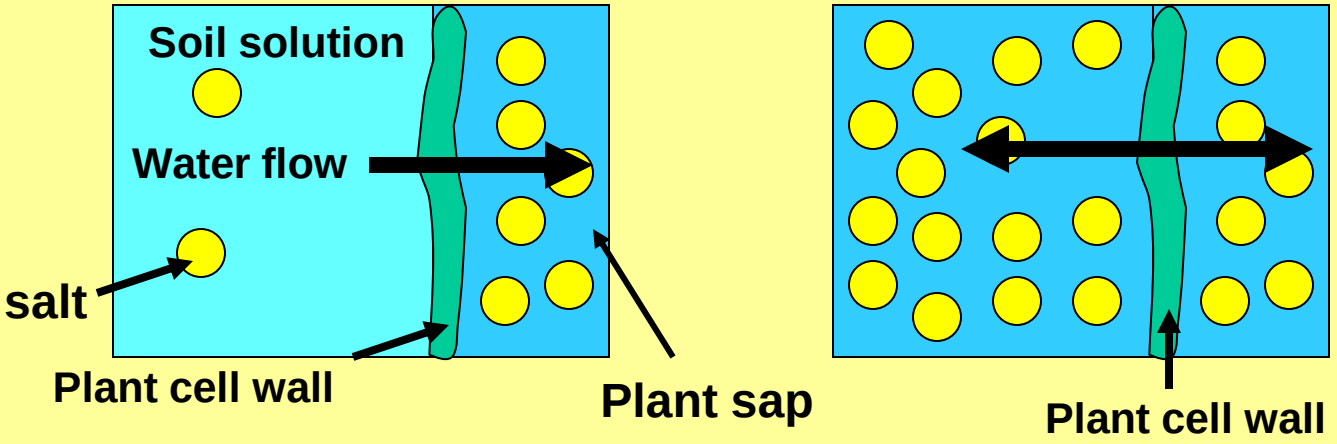
Osmotic affect caused by Salts hurt plant growth

Saline Soil (white salt)

<u>Osmotic affect restricts plant growth:</u> 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.



Saline Soil Classes

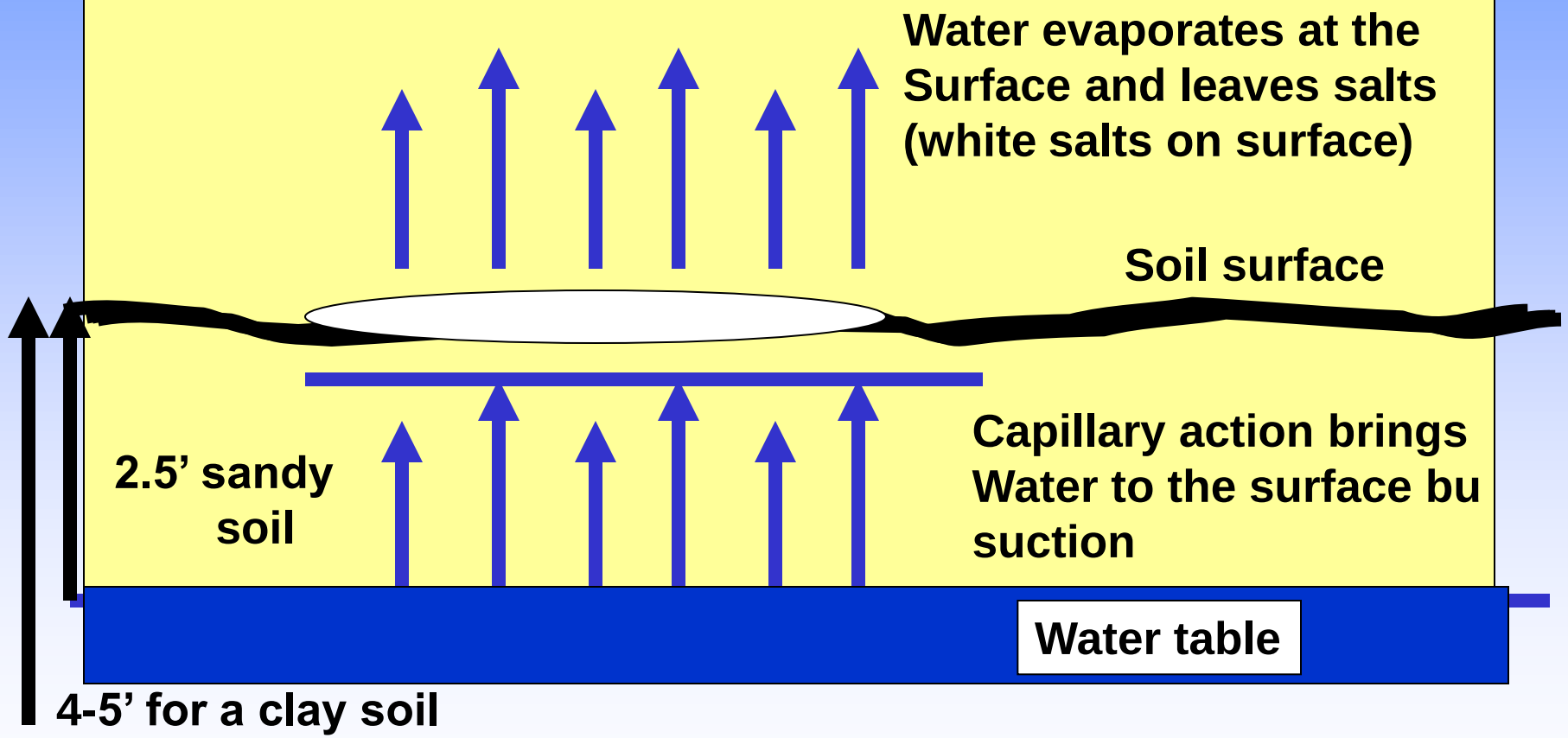
*** Based on routine laboratory 1:1 soil to water method**

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 Soils

- How do soils become saline?

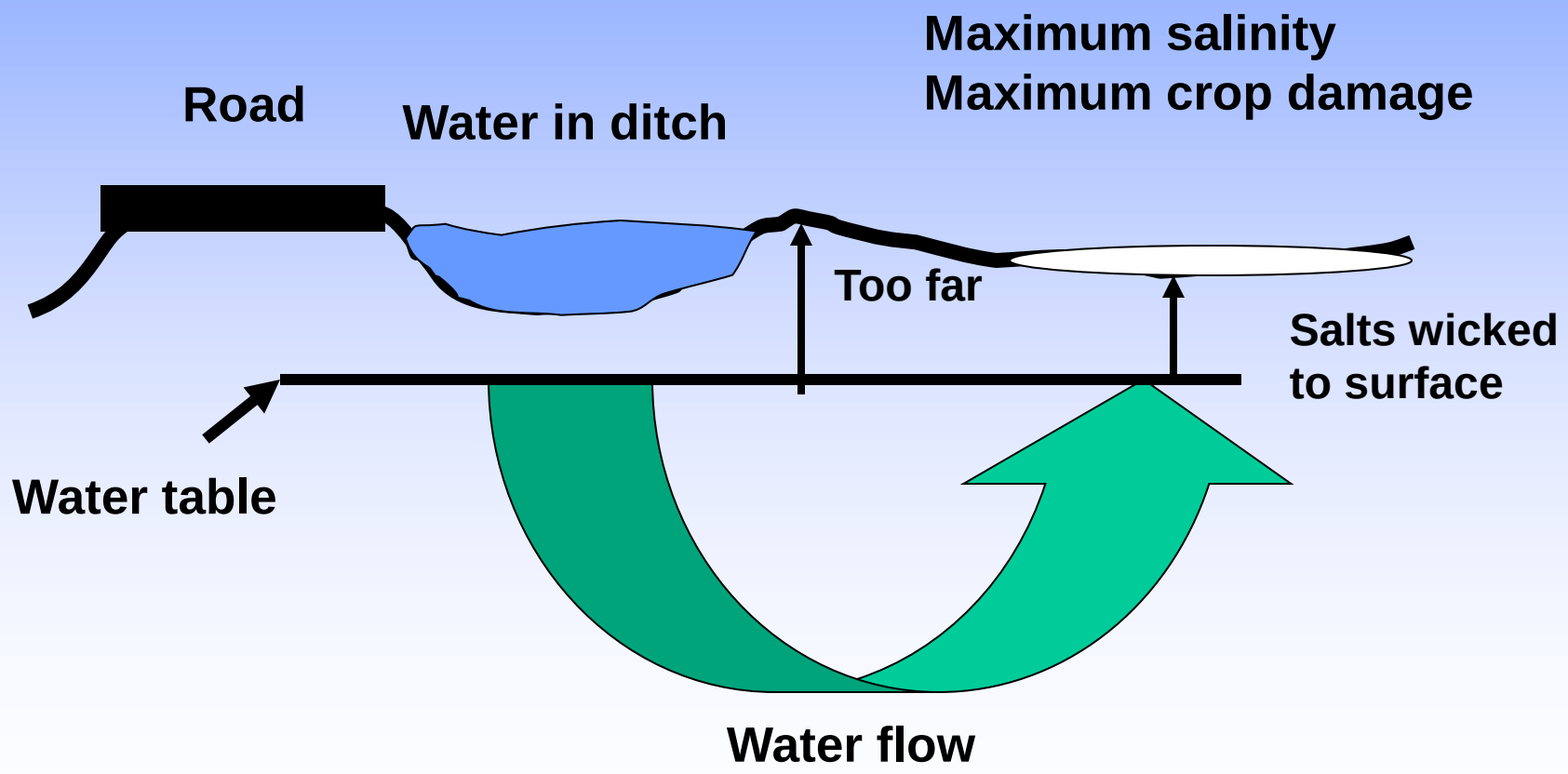


A series of wet years will bring the water table closer to the surface and salt levels will increase at the surface increasing saline area size

Salinity Near Drainage Ditch

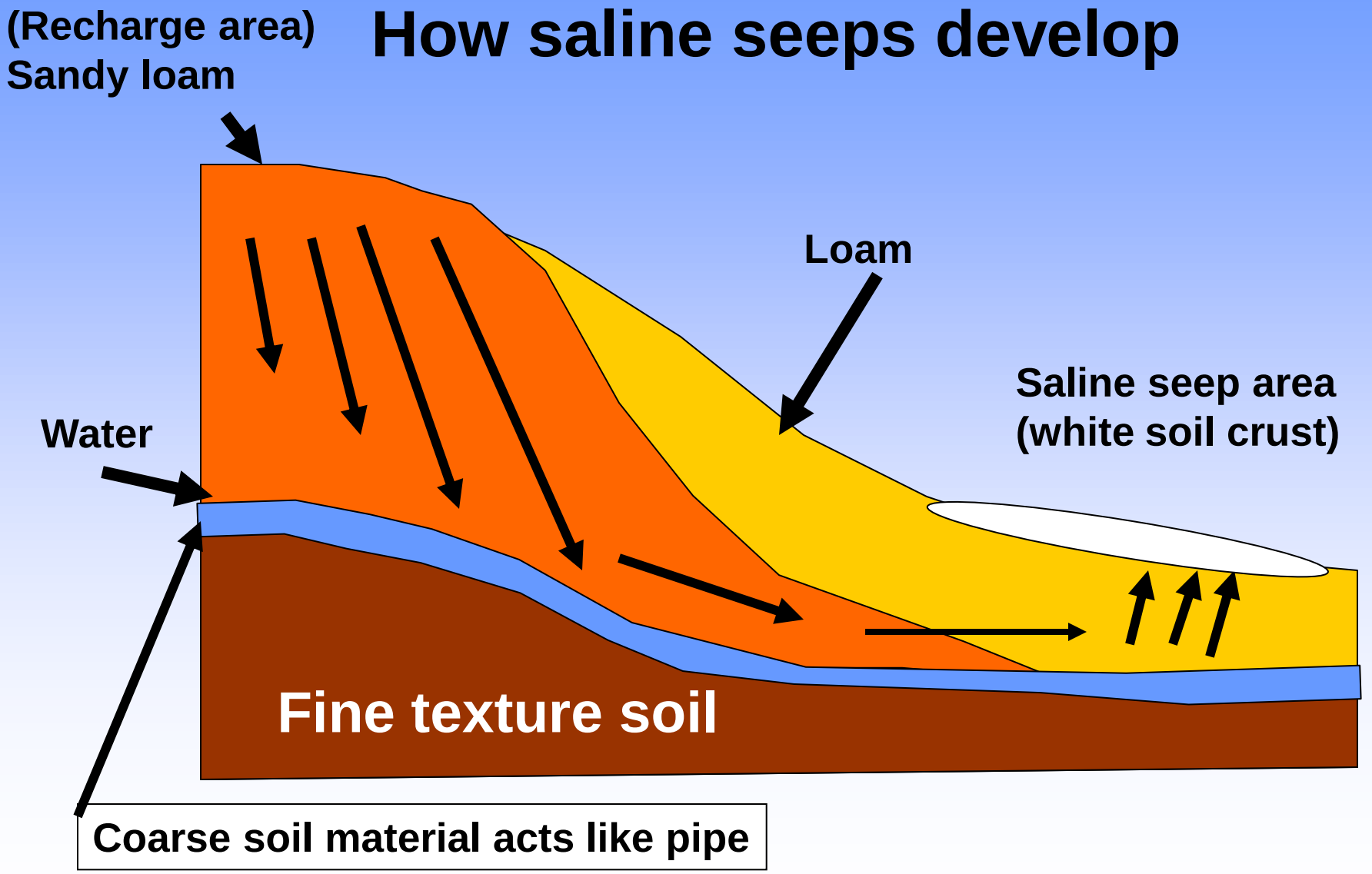
Saline Soils

Saline soil beside drainage ditch

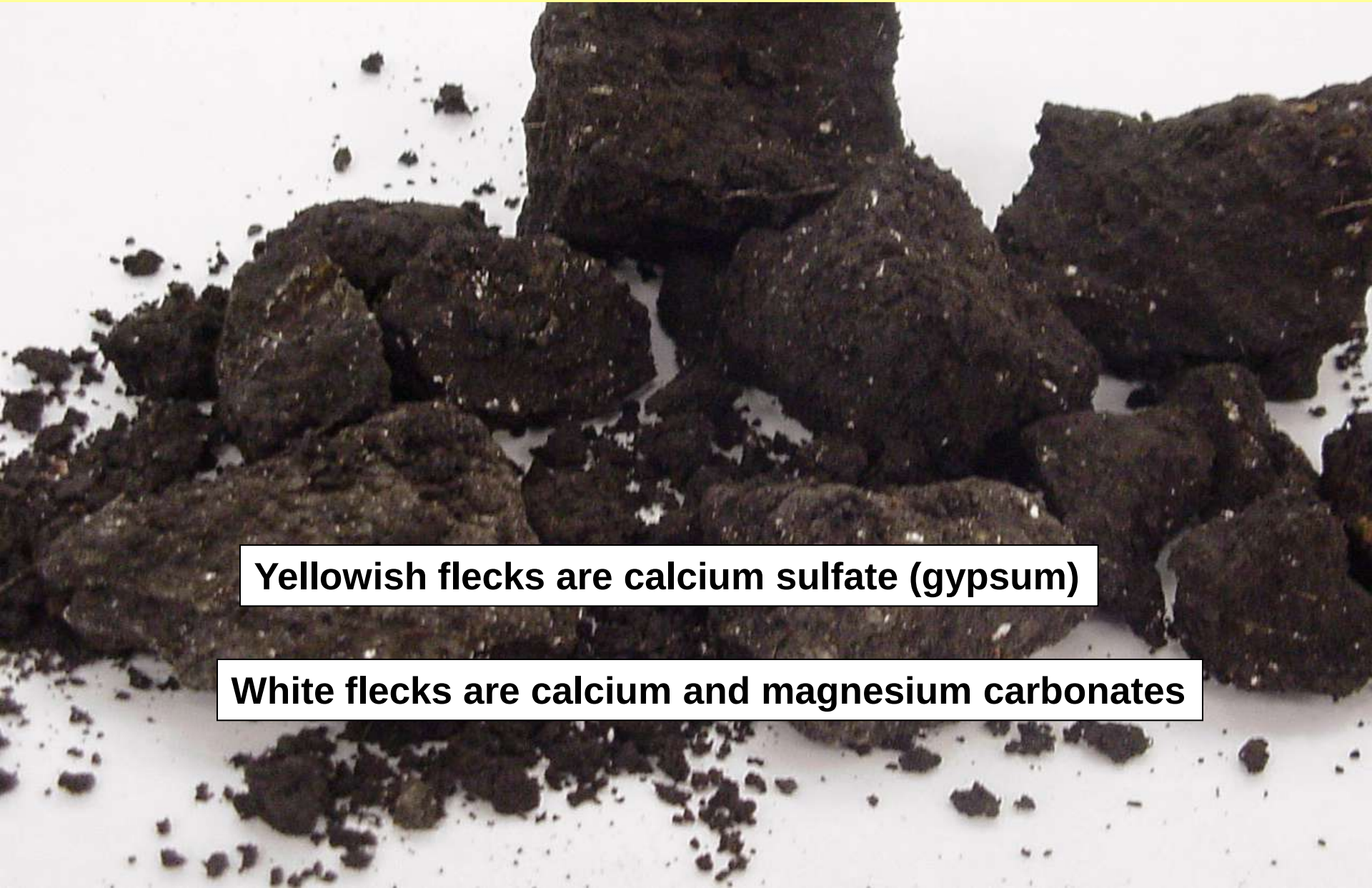


Saline Soils - Seeps

How saline seeps develop



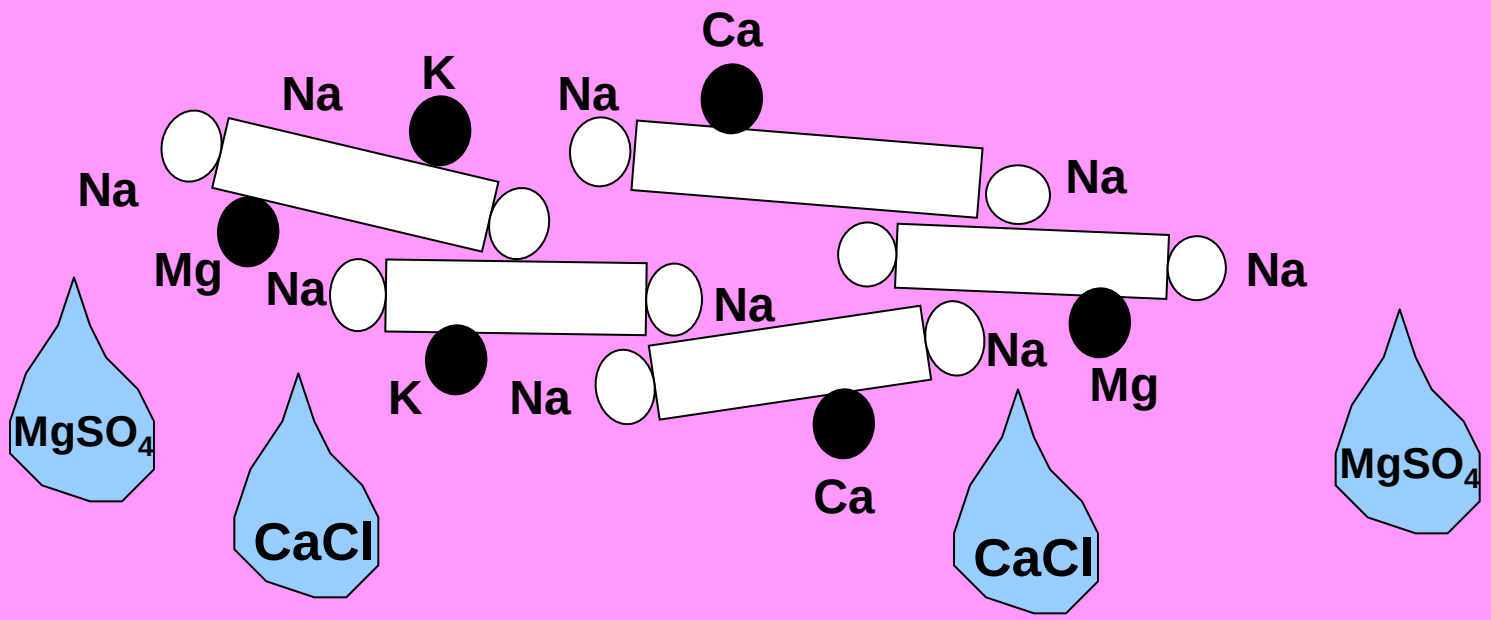
Saline Soil Structure



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

Sodic Soil

- Soil Test Levels
  - >3-5% sodium on base saturation
  - >15% sodium is defined as sodic soil
  - pH greater than 8.5
  - Low soluble salts (<2.0 mmhos/cm 1:1 method)
- Sodic soils can occur naturally
- Sodic soils are created by poor irrigation techniques
- Many sodic soils also have high salts

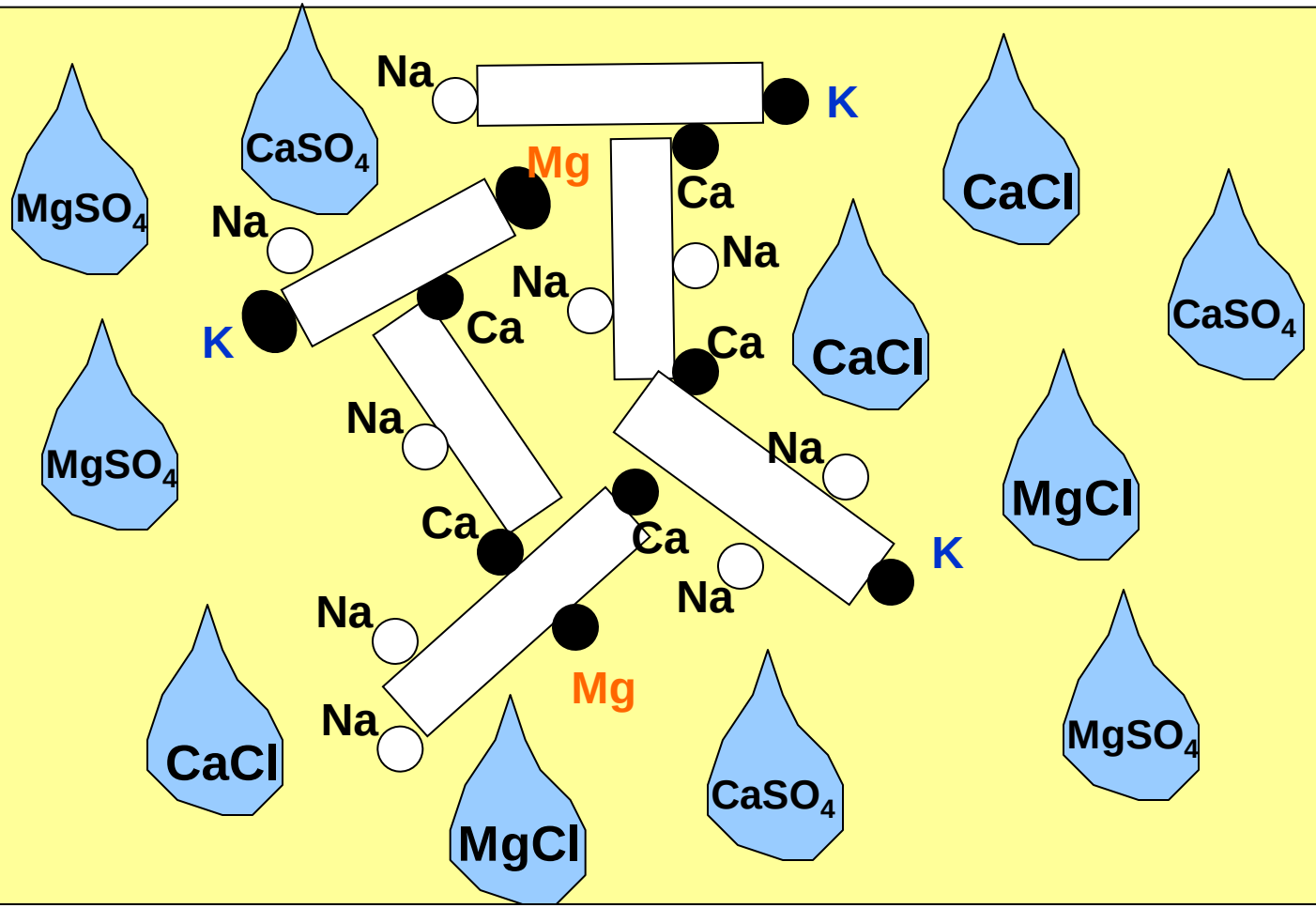
Sodic Soil

- Physical problems
  - High sodium destroys soil structure (wet pudding)
  - High sodium seals surface (poor infiltration)
  - High sodium reduces water percolatation 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

Saline and Sodic (Real Mess)

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

Fair soil structure because excessive salts keep soil flocculated (soft)
Fair water infiltration because excessive salts



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


Saline
Good
Sodic & Saline


Reclaiming Sodic Soil must include improved drainage!
Tile drainage installed in 2007

Crop Rotation

- 2005 Corn
- 2006 Corn
- 2007 Corn (Tile installed)
- 2008 Corn
- 2009 Prevent Plant
- 2010 Winter wheat
- 2011 Corn

Amending Sodic Soils

- Gypsum – $CaSO_4$
  - Most commonly used calcium amendment for reclaiming sodic soils
  - Relatively inexpensive
  - Common rates are tons/acre

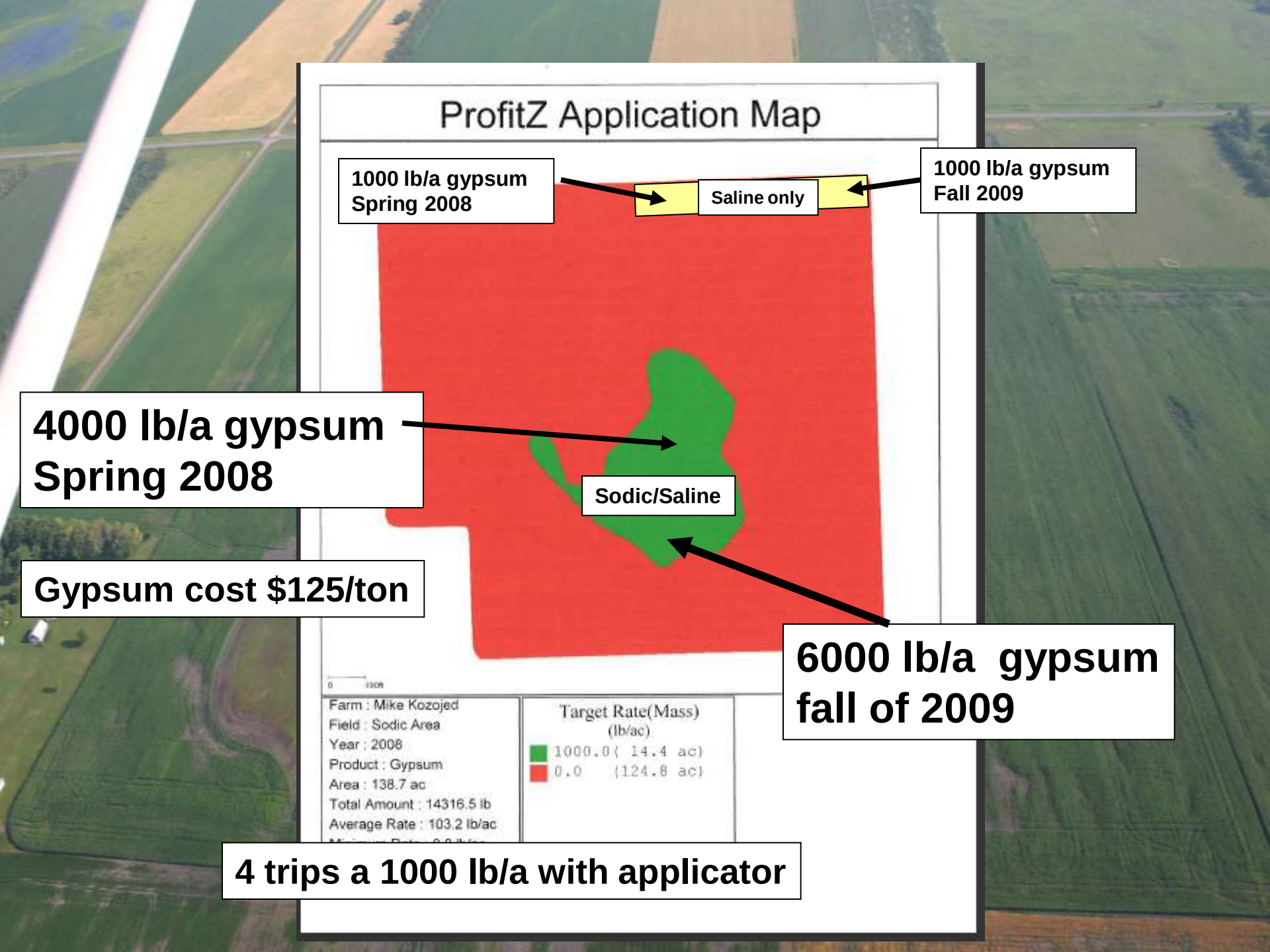
Amending Sodic Soils

- Calcium (Ca^{+2}) replaces Sodium (Na^{+1}) on the soil
  - Calcium forms a stronger bond than sodium
- Sodium must be leached out of the soil (Tile)
- 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

How much Gypsum to apply?

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

AGVISE Soil Scientists will help with calculation!


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
Farm : Mike Kozojed
Field : Sodic Area
Year : 2008
Product : Gypsum
Area : 138.7 ac
Total Amount : 14316.5 lb
Average Rate : 103.2 lb/ac
Target Rate(Mass)
(lb/ac)
1000.0 (14.4 ac)
0.0 (124.8 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 area***
  - Tile drainage will remove salt from the topsoil first improving germination and production.
- ***Highly Productive area***
  - Tile drainage will allow earlier planting and reduce losses of N due to denitrification

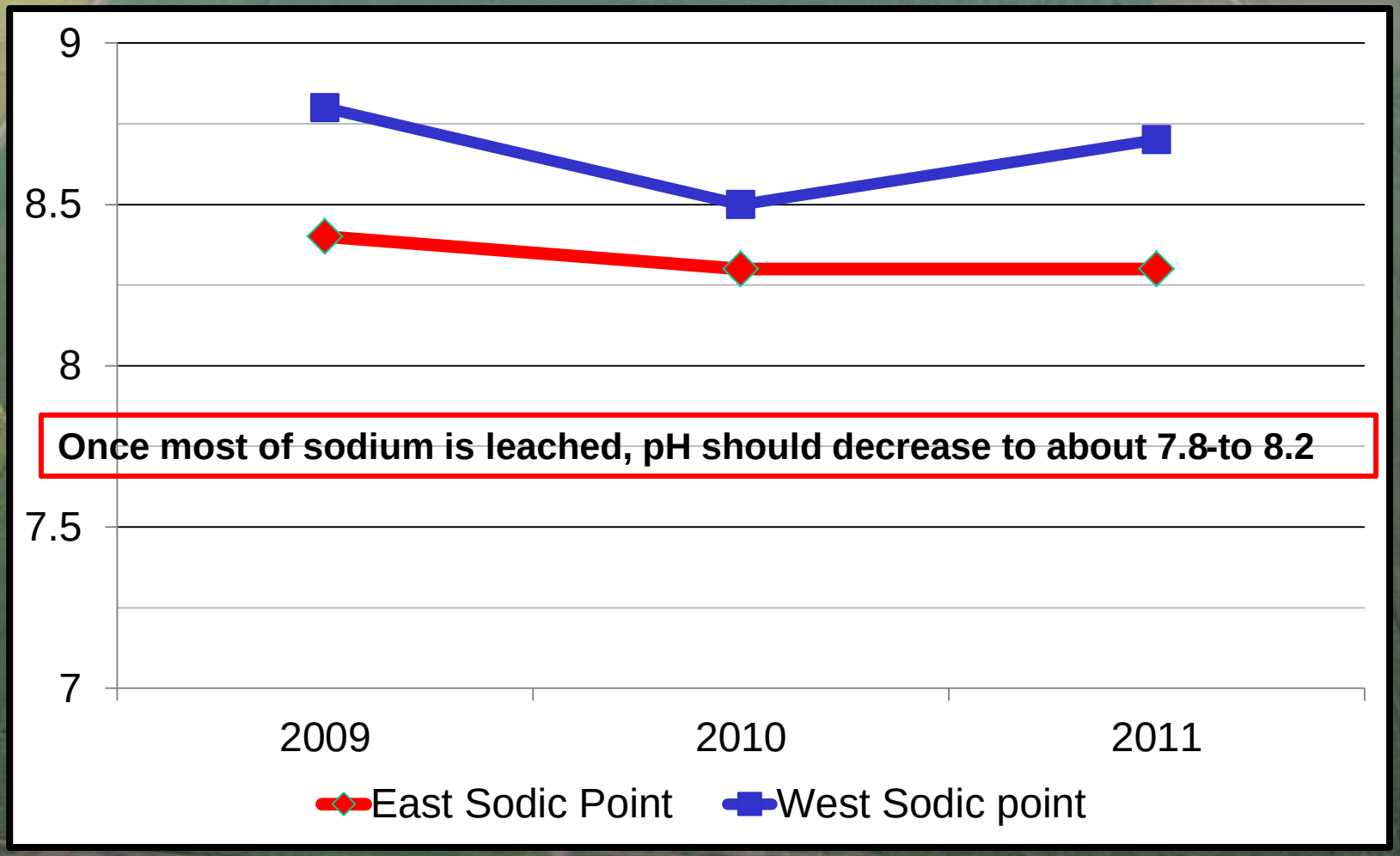
Salt Tolerance of Field Crops

(Based on 1:1 common Salt Method)

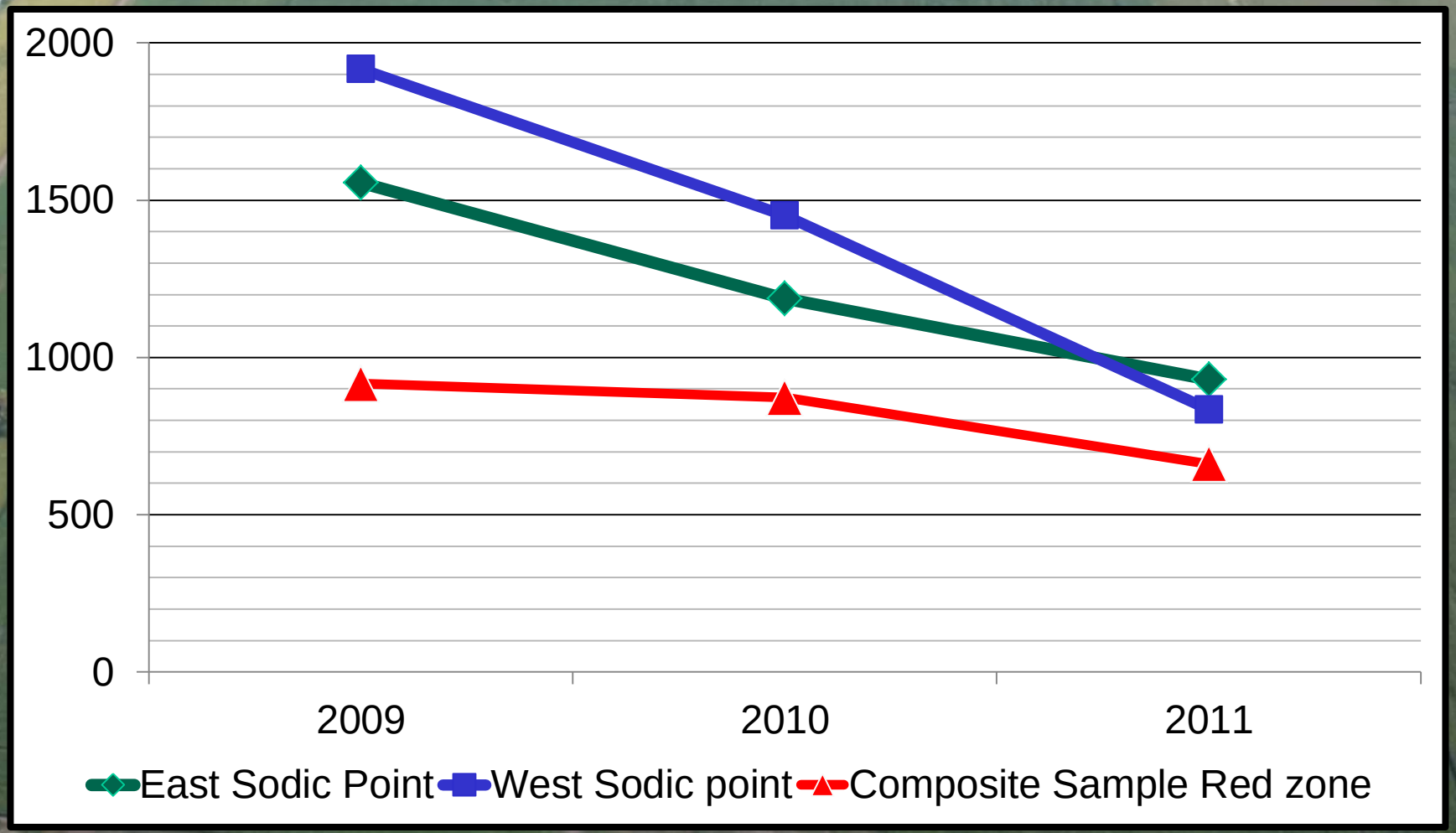
Crop	Salt Level 100% Yield	Salt Level 75% Yield	Salt Level 50% Yield
Barley	1.7	2.7	3.4
Sugarbeets	1.6	2.6	3.3
*Corn	1.2	1.5	2.5
Wheat	1.0	1.7	2.3
Flax	.9	1.3	2.0
Canola	.9	1.3	2.0
Soybeans	.8	1.2	1.8
Potatoes	.8	1.2	1.8
Edible Beans	.6	1.1	1.6

*Corn tolerates moderate salinity and uses lots of water through the season

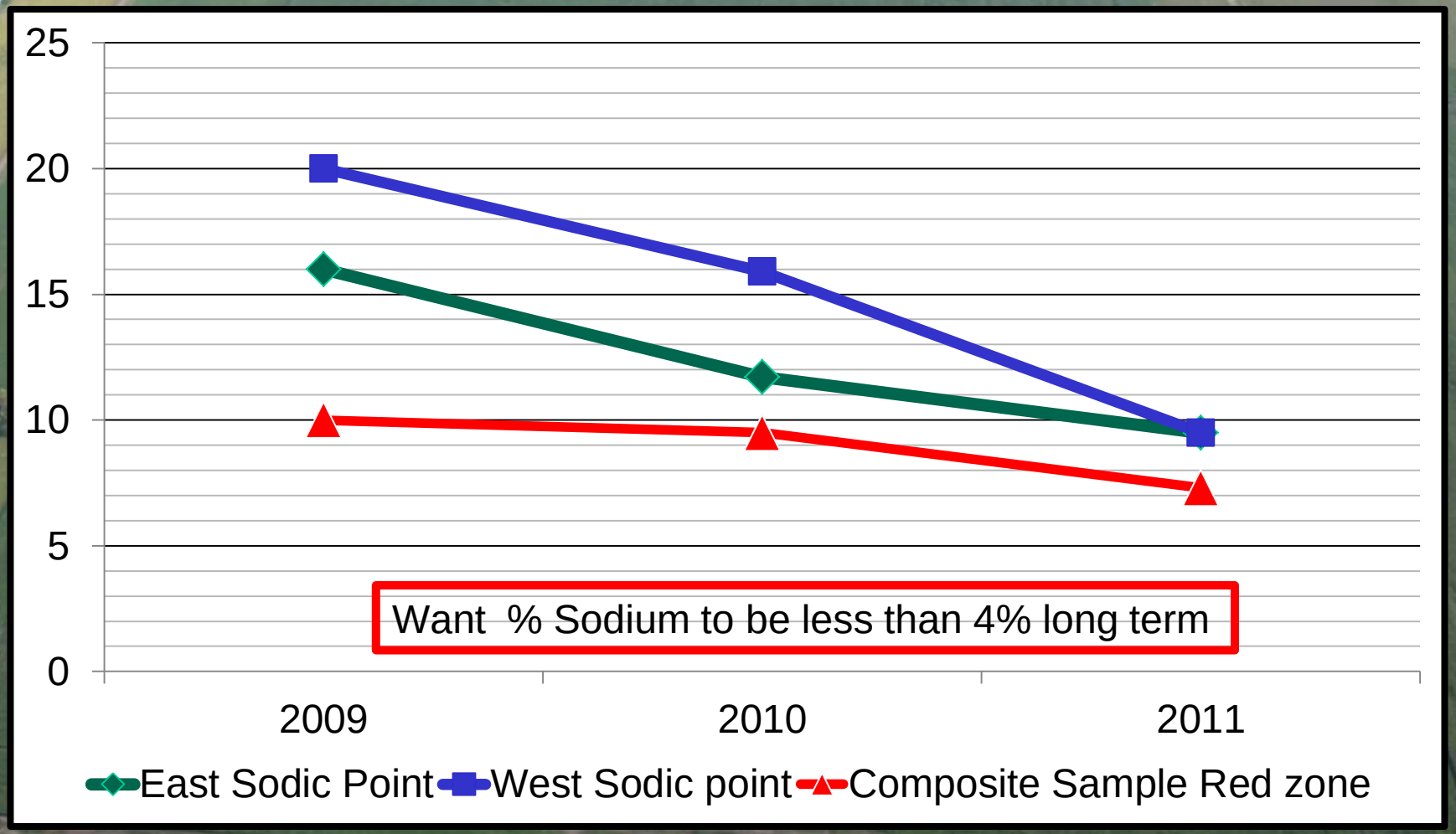
Has Gypsum Decreased Soil pH?



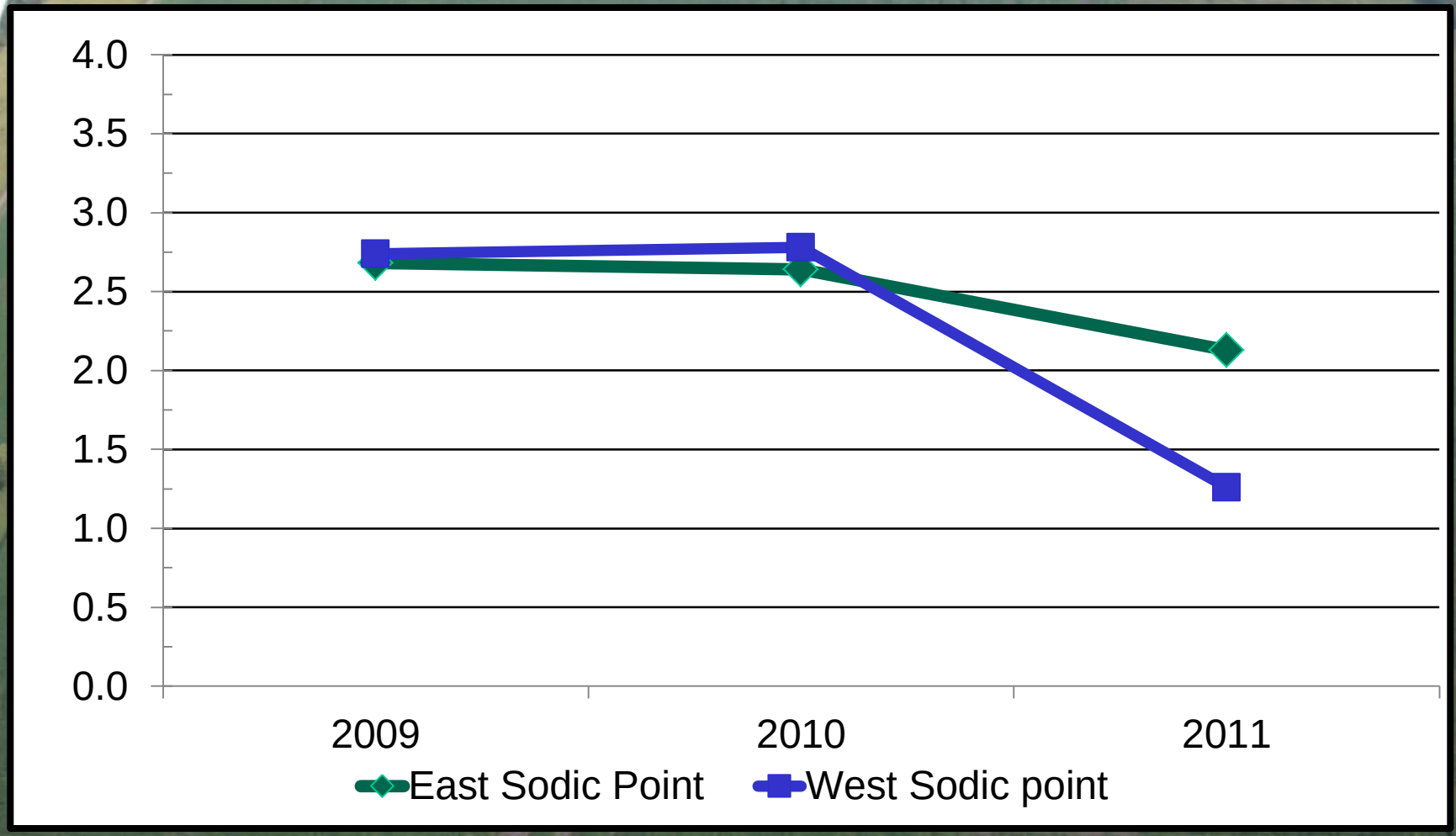
Sodium Levels Have Decreased



% Sodium Has Decreased

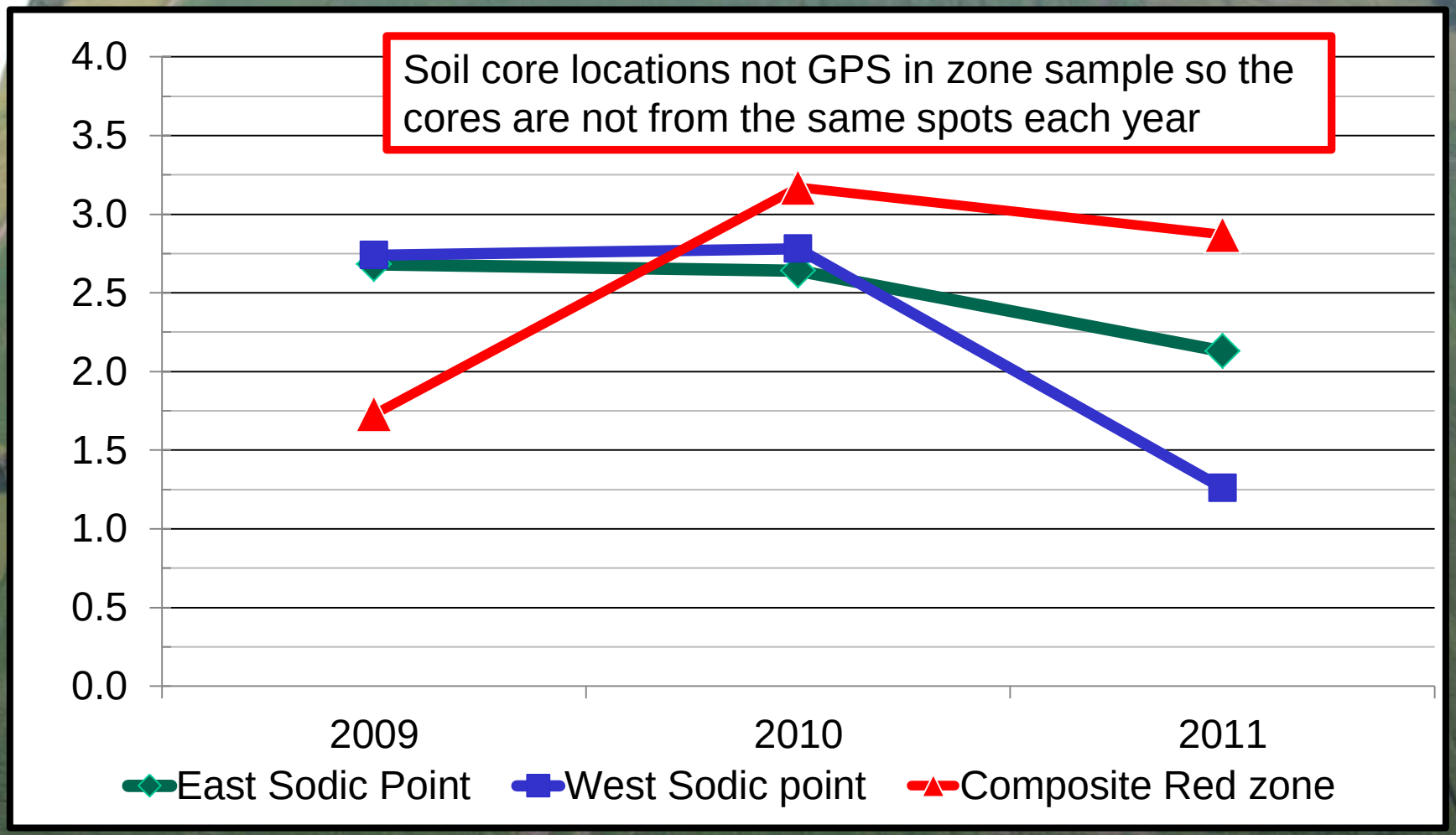


Soluble Salt Levels

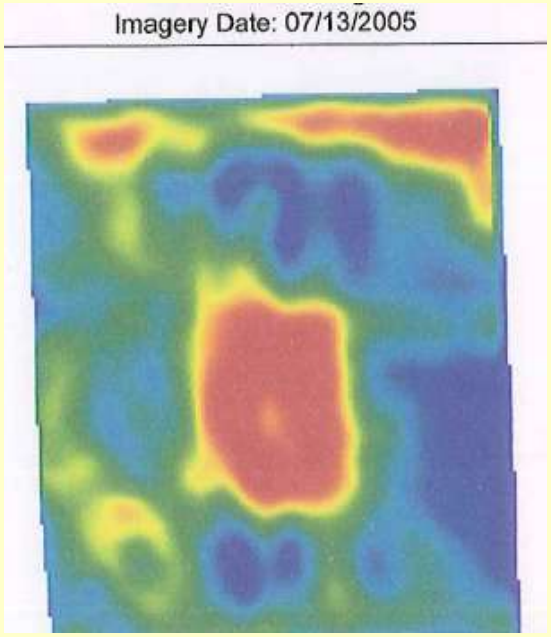


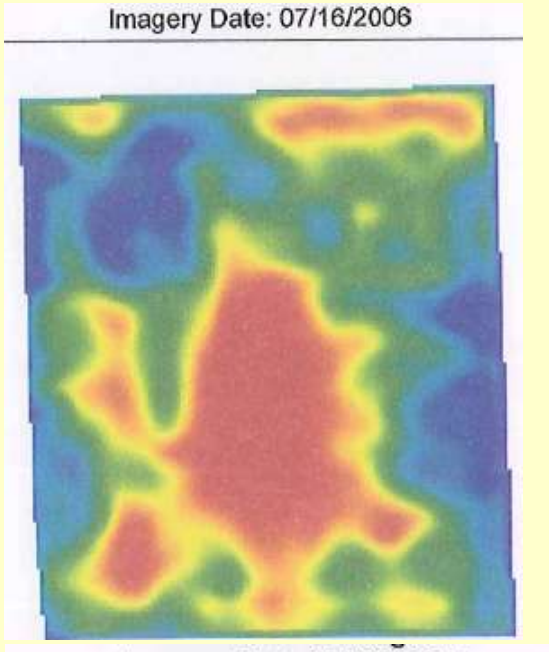
1:1 routine salt method

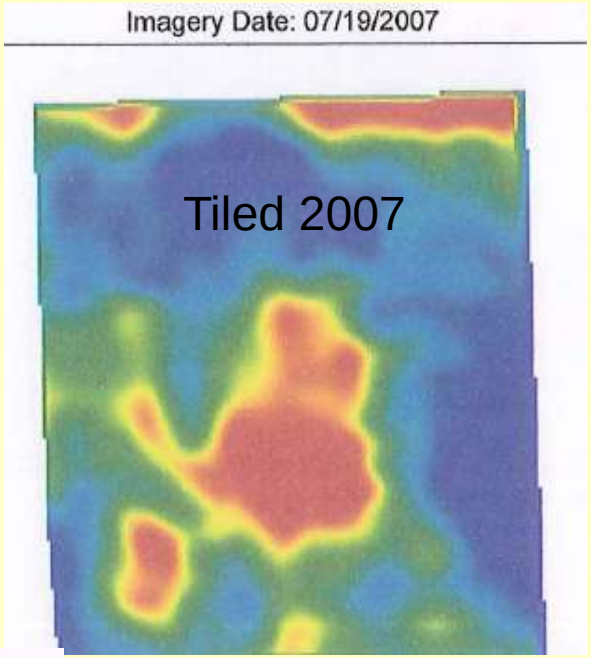
Soluble Salt Levels

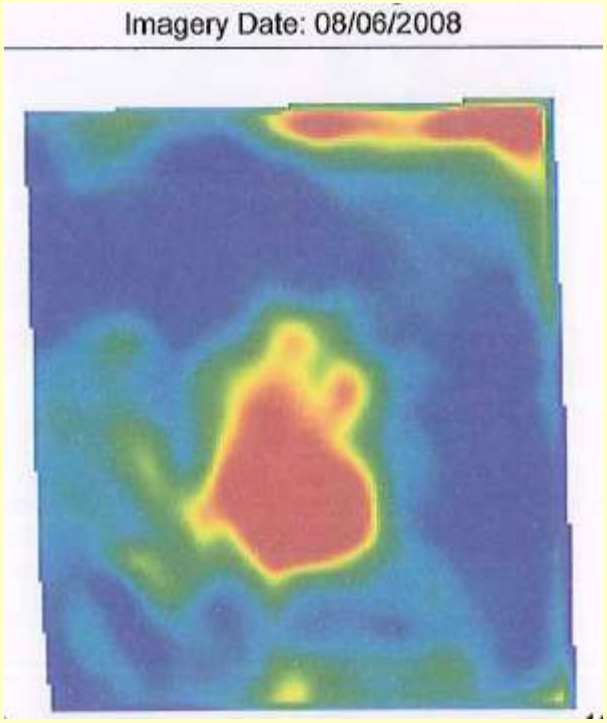


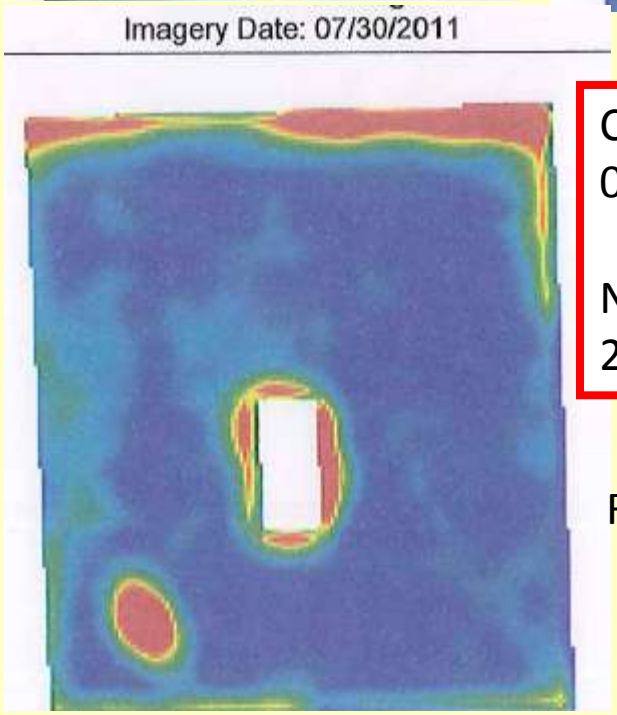
1:1 routine salt method











Corn vegetation images
05,06,07,08,2011

No images
2009 PP, 2010 winter wheat

Red = Bare surface/low veg

Blue = High vegetation

2008 corn – 82 bu/a

Dry Yield

Mike Kozojed - Mike Kozojed - Norway 2 NW 1_4

APEX Farm Management Software

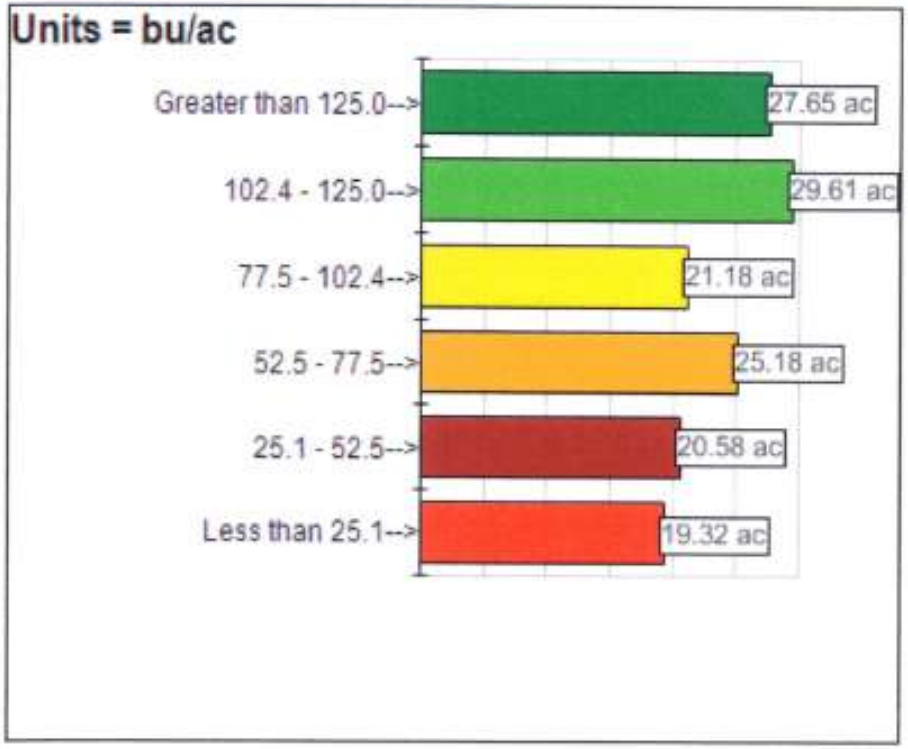
Client Information:

Client:	Mike Kozojed
Farm:	Mike Kozojed
Field:	Norway 2 NW 1_4

Field Information:

Crop:	Corn
Start Date:	11/12/2008
Product:	Corn
Elapsed Time:	11.326 h
Area:	143.55 ac
Average Yield:	82.1 bu/ac
Average Dry Weight:	4,595.1 lb/ac
Total Yield:	11,778.9 bu
Total Dry Weight:	659,619 lb
Average Moisture:	21.54 %
Productivity(area/hour):	12.67 ac/h

Legend Information:



Field information and legend apply to active map layer only.

2011 corn – 130 bu/a

Dry Yield

Mike Kozojed - Mike Kozojed - Norway 2 NW 1_4

APEX Farm Management Software

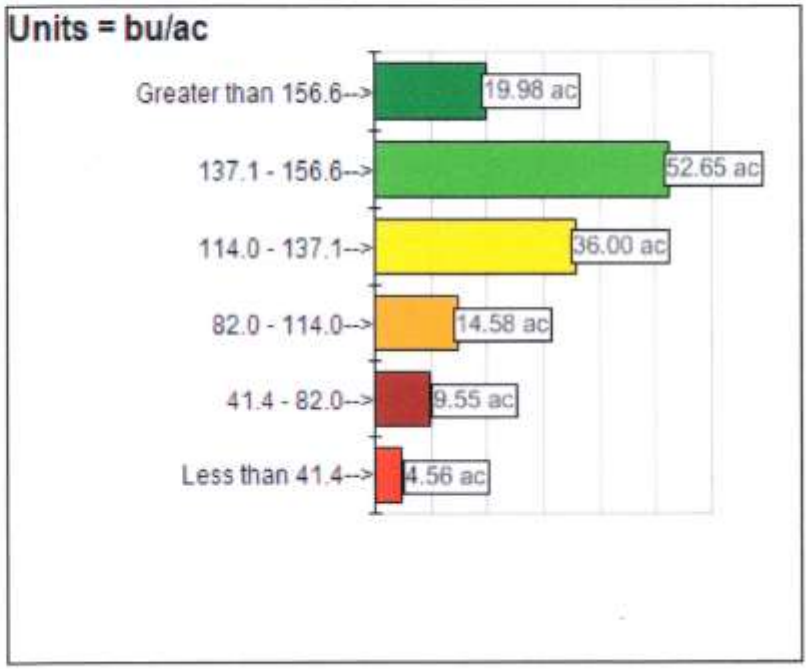
Client Information:

Client:	Mike Kozojed
Farm:	Mike Kozojed
Field:	Norway 2 NW 1_4

Field Information:

Crop:	Corn
Start Date:	10/8/2011
Product:	Corn
Elapsed Time:	9.505 h
Area:	137.32 ac
Average Yield:	130.3 bu/ac
Average Dry Weight:	7,297.0 lb/ac
Total Yield:	17,893.6 bu
Total Dry Weight:	1,002,041 lb
Average Moisture:	14.98 %
Productivity(area/hour):	14.45 ac/h

Legend Information:



Field information and legend apply to active map layer only.

Sodic Soil - Gypsum Project

- AGVISE will continue to test soil each fall (Sampling by Greg Reidman) for 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


Questions?