Soil Salinity
The Baddy of Marginal Soils

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nutrient stewardship

Who am I?

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eKonomics on sAlinity

Soil Salinity 101

Episode 4: Is Soil Salinity Impacting Your Crops?

Soil Salinity In Western Canada

Soil Salinity and So

In Some Business, ‘Poor Profit’ is Well Recognized

If a cow is no longer productive – it is culled.

If a portion of an orchard is unproductive, it is removed.

If a store in a chain is losing money, its closed.

If some of our grain farm is losing money? We try again.

Would we make more $$ if we farmed less land?

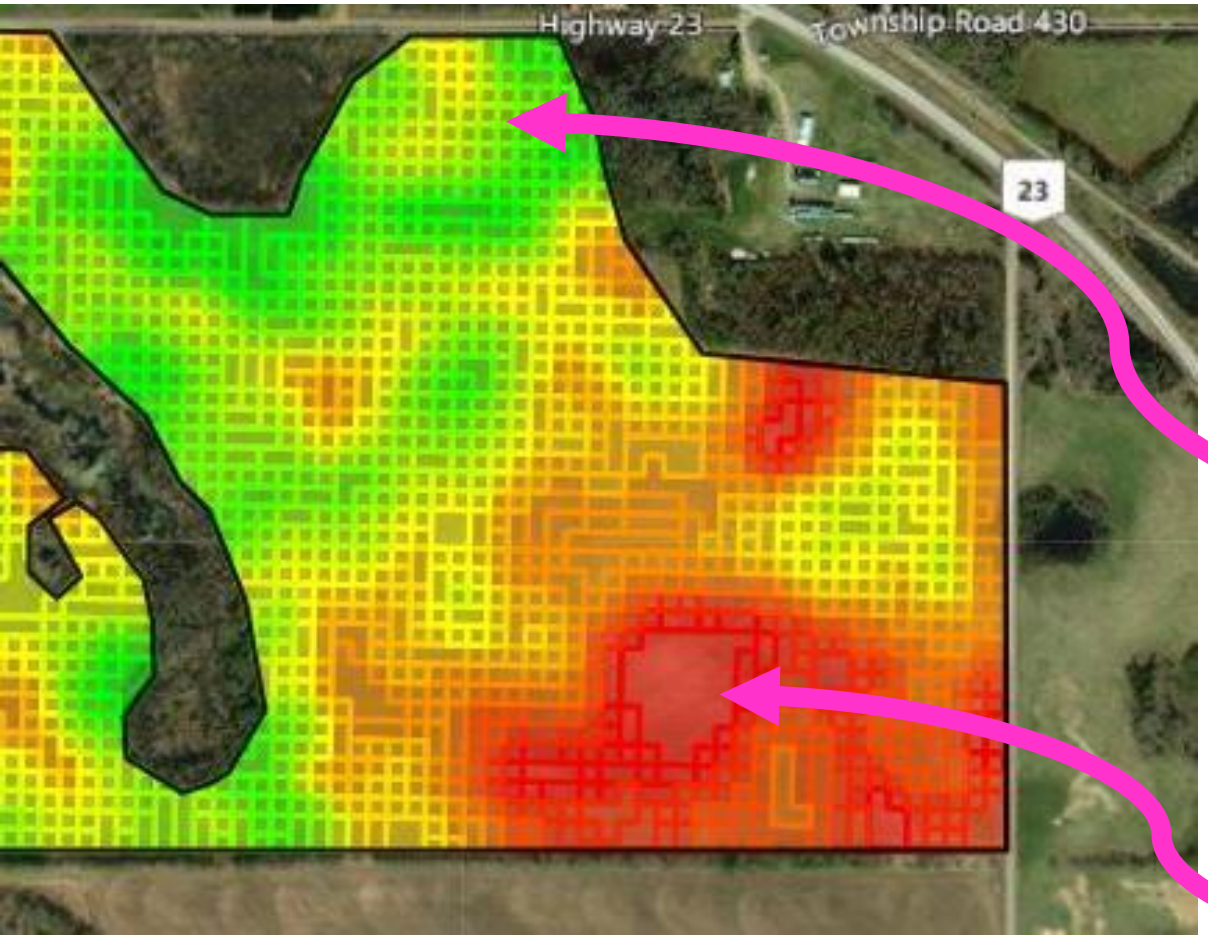
Soil Limits in Perspective

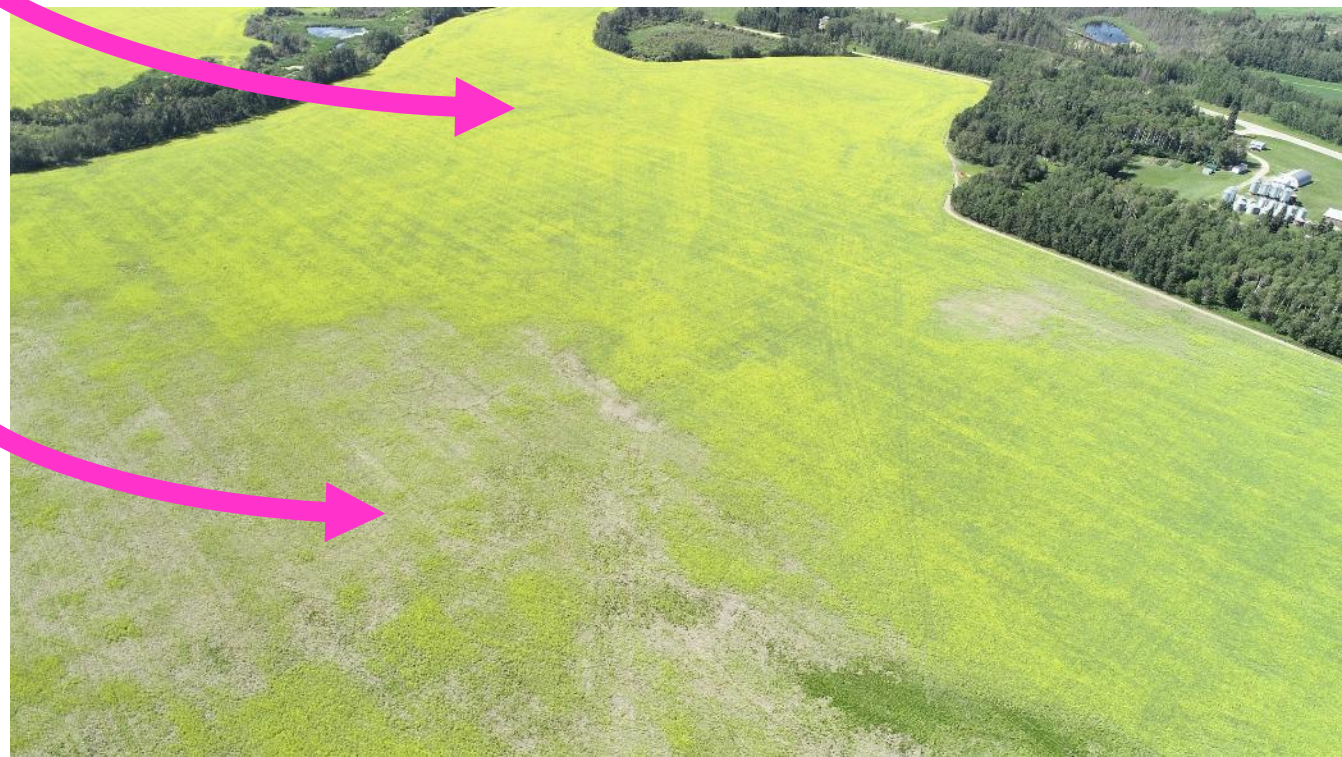
Soil Factor	Impact	Potential to Fix	Other
Salinity	**Big**	**Very Low**	**It can grow!**
Acidity	Very Small	Yes – but $$	
Flooding	Variable	Medium	Often Saline
Low fertility	Big	Very good	Soil/Tissue test
Compaction	Growing	Medium-Depth?	Better to avoid
Solonetzic Soil	**Medium**	**Very low**	**Stable**
Peat moss	Small	Very low	Grow trees
Drought - Texture	Big	Medium	Direct Seed
Eroded soils	Medium?	Medium	Direct Seed

Our problem with square fields and large equipment

Somewhere in Britain

Marginal Soils Know No Boundaries





So what are the salts you speak of?

A ‘salt’ is a dissolved mineral. Sometimes we call these ‘nutrients’, but ‘soil salinity’ involves 1000s of lbs per acre….

Na^{+}, Ca^{2+}, Mg^{2+} paired with SO^{4-}, Cl^{-}, CO_3^{2-}

Calcium Sulphate and Magnesium Sulphate likely key pairs.

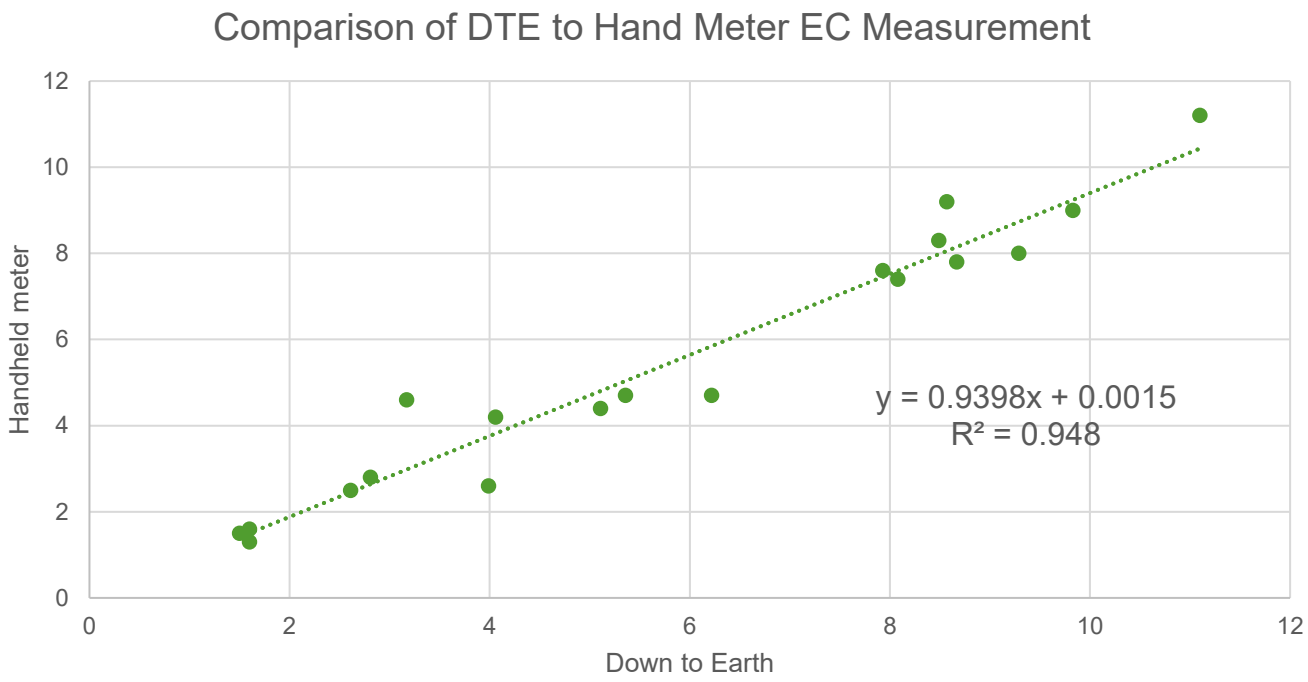
Salts can carry electricity through water.

We can measure the rate of electrical conductivity.

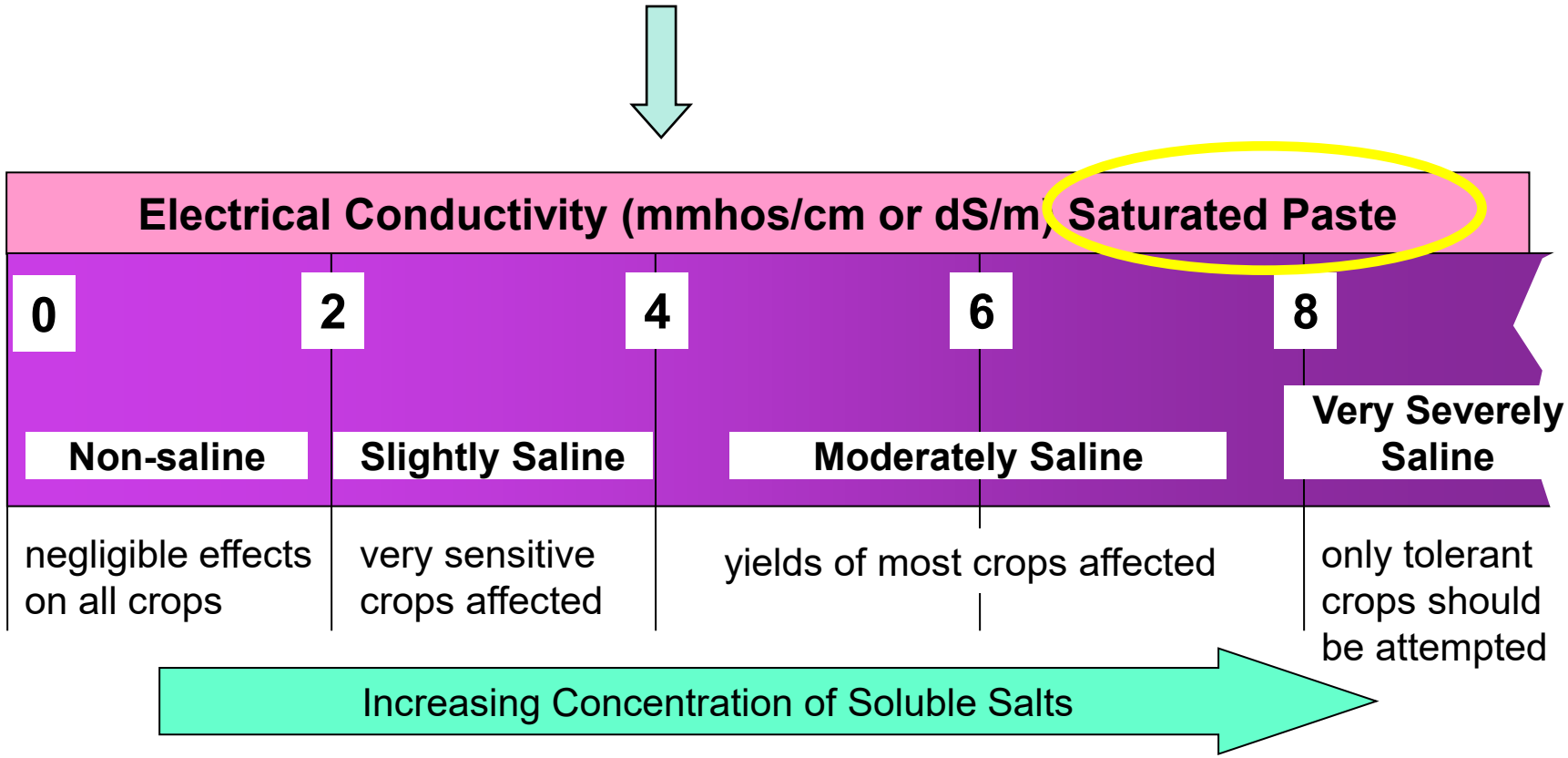
We measure soil salinity in conductivity units of millisiemens per cm (mS/cm)

Measuring Salinity – Electrical Conductivity

- Most labs use a ratio of water:soil such as 1:1 or 2:1
- You can also do this yourself with a $50 meter



Measuring Soil Salinity – Saturated Paste Standards



Crops and salinity….Standard is ‘4 ms per cm SP’

What is this ‘saturated paste’ you speak of?

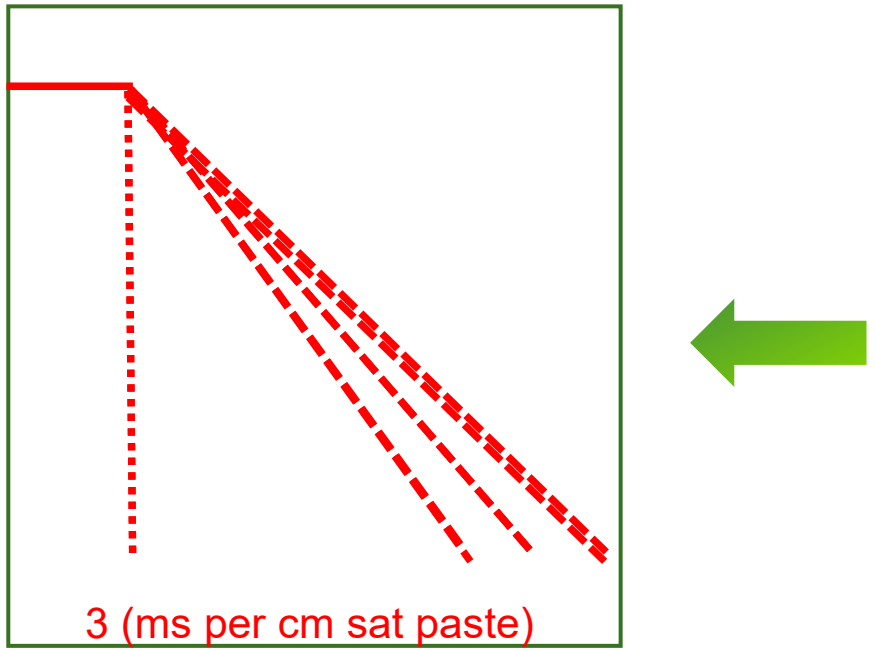
Well….its an impractical way to estimate salinity

Most labs use a ratio of Soil:Water

If your lab uses a ratio of 1:1 then multiply by about 2.2 = SP

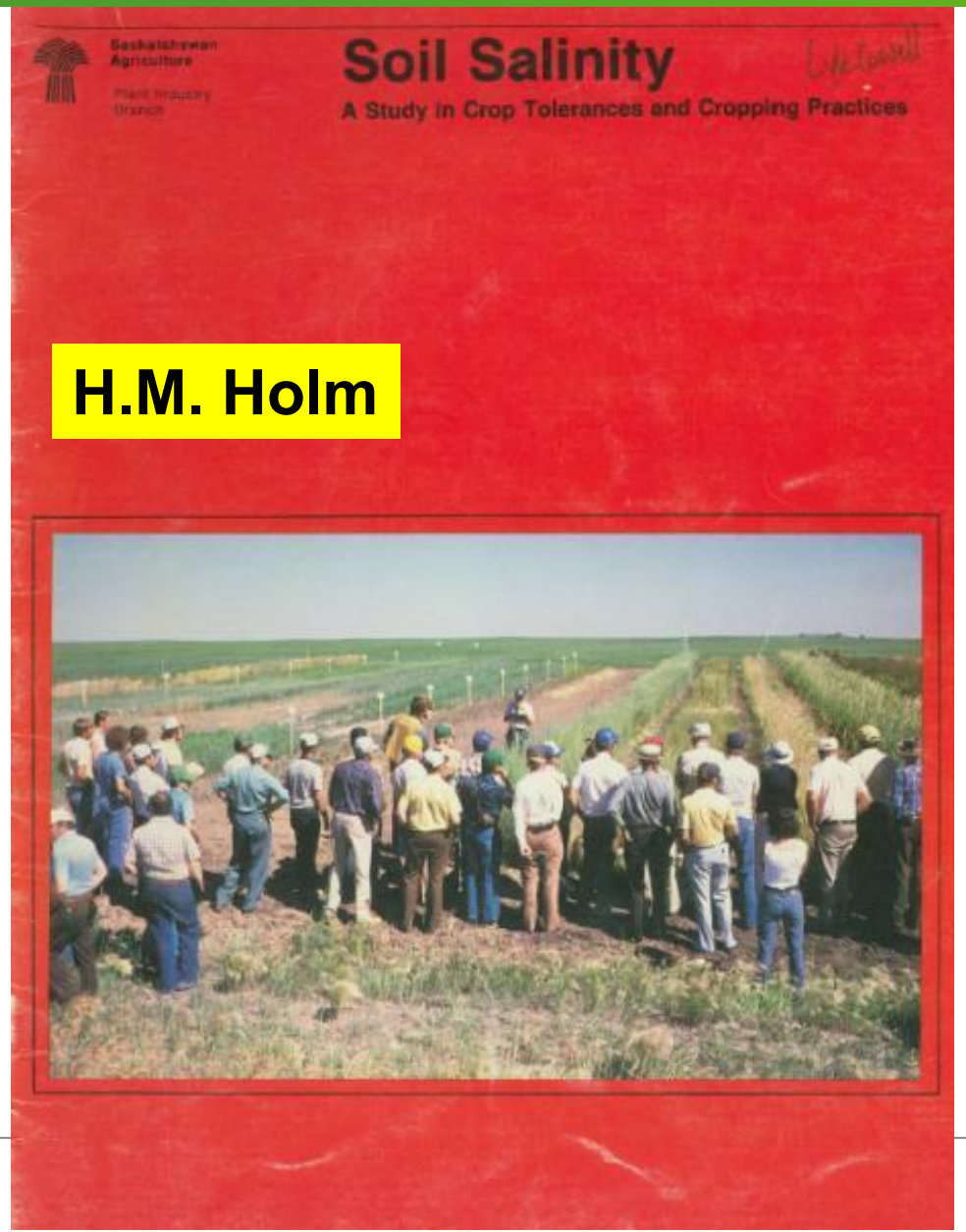
	Non-saline	Slightly Saline	Moderately Saline	Severely saline	Very severely saline
	Electrical Conductivity (measured in 1:1 ratio of Soil:Water, loam soil)				
	<0.9	1.0-1.8	1.9-3.6	3.7-7.2	> 7.2
Visible Signs	No Visible signs of salts nor any impact on crop growth at any stage	Yields of most sensitive crops reduced, probably no visible sign of salts	Yields of most annual crops restricted. Wheat yields reduced 25% and Alfalfa 12% at EC 2.5. Salts often visible on soil surface in dry periods.	Annual crops not recommended. Yield loss in sensitive forages. Wheat yields reduced 80% and Alfalfa 40% at EC 5.0. Salts visible on soil surface.	Only a few perennial grass species suitable. Established alfalfa yields reduced by 70% at EC 7.0. Salts visible on soil surface.
Annual Crops	Field Beans. Soybeans, Pulse Crops, Corn Sunflower	Canola, Mustard, Oats, Rye, Wheat, Flax	Barley, Sugarbeets		
Forage Crops	Red clover, Alsike clover, Timothy	Reed canarygrass, Meadow fescue, Meadow Bromegrass, Crested wheatgrass	Smooth Brome, Alfalfa, Sweet Clover	Tall Wheatgrass, Altai wild ryegrass	Russian wild ryegrass, Tall wheatgrass, Saltlander green wheatgrass

Yields tend to decline linearly with salinity



Example: Wheat yield = -10 EC (saturated paste) + 100 **Holm, 1983**

Two VERY Important Publications

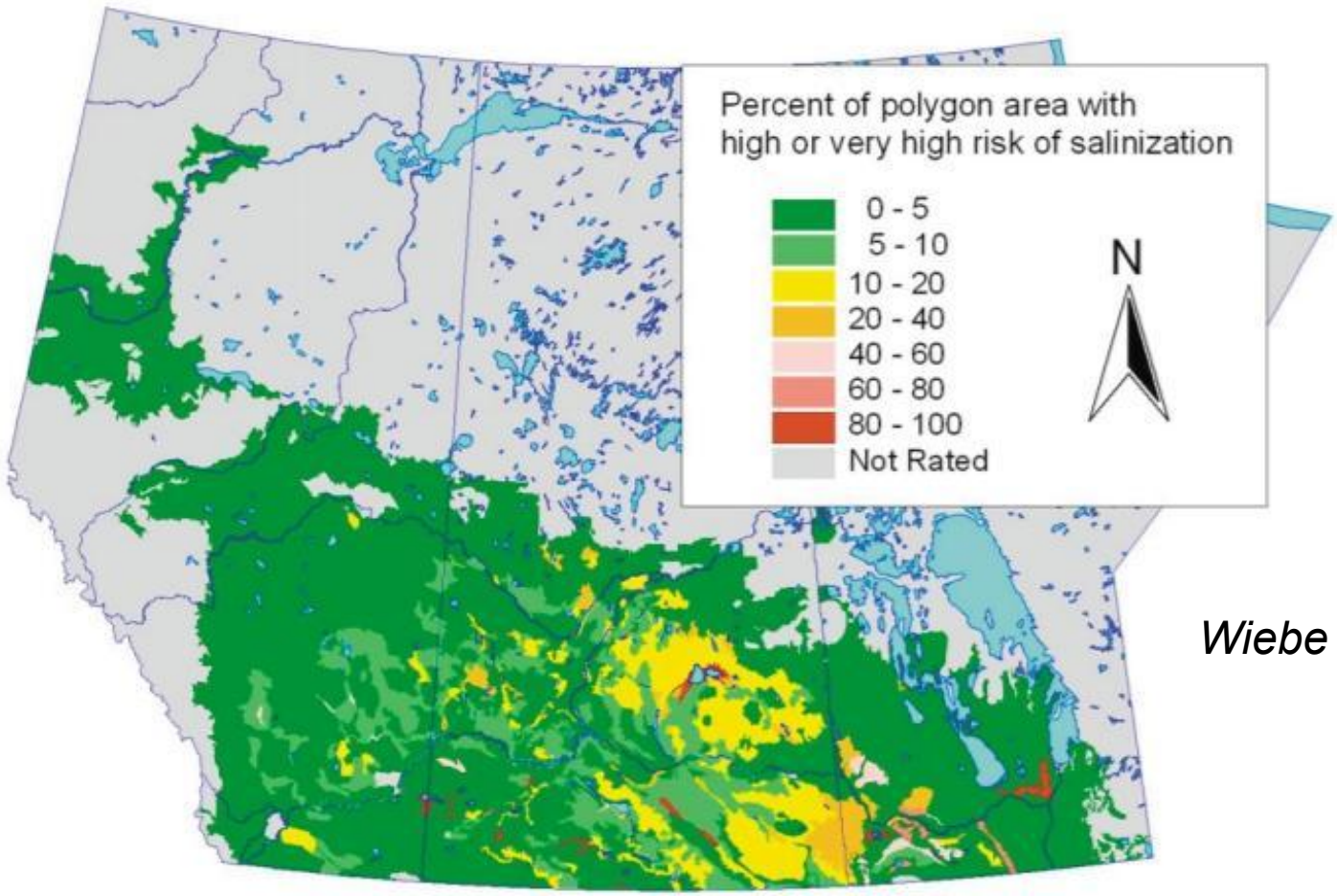


H.M. Holm

Nature and Management of Salt-Affected Land in Saskatchewan

http://publications.gov.sk.ca/documents/20/84797-salt-affected%20lands.pdf

Risk to development of salinity



Wiebe et al, 2006

Salinity affects 2.5M million acres in western Canada
Risk to 5-6M acres. <u>It's a big deal.</u>

The big changes over the past 20 years??

Good? We have mostly stopped fallow

Bad? We have encroached on marginal land for annual crops

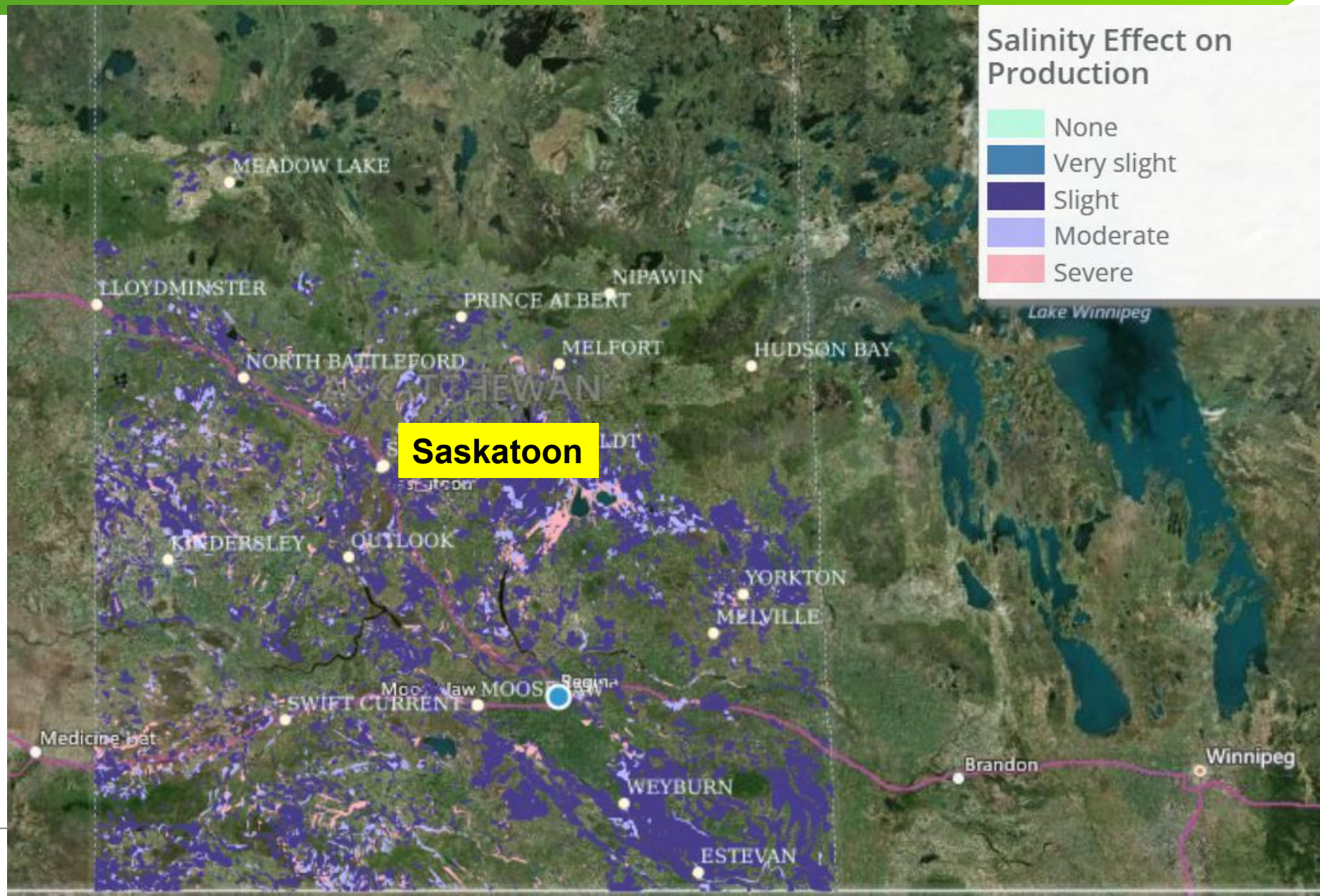
SK SIS Salinity https://sksis.ca/map

Slight =
4 to 8 ms per cm

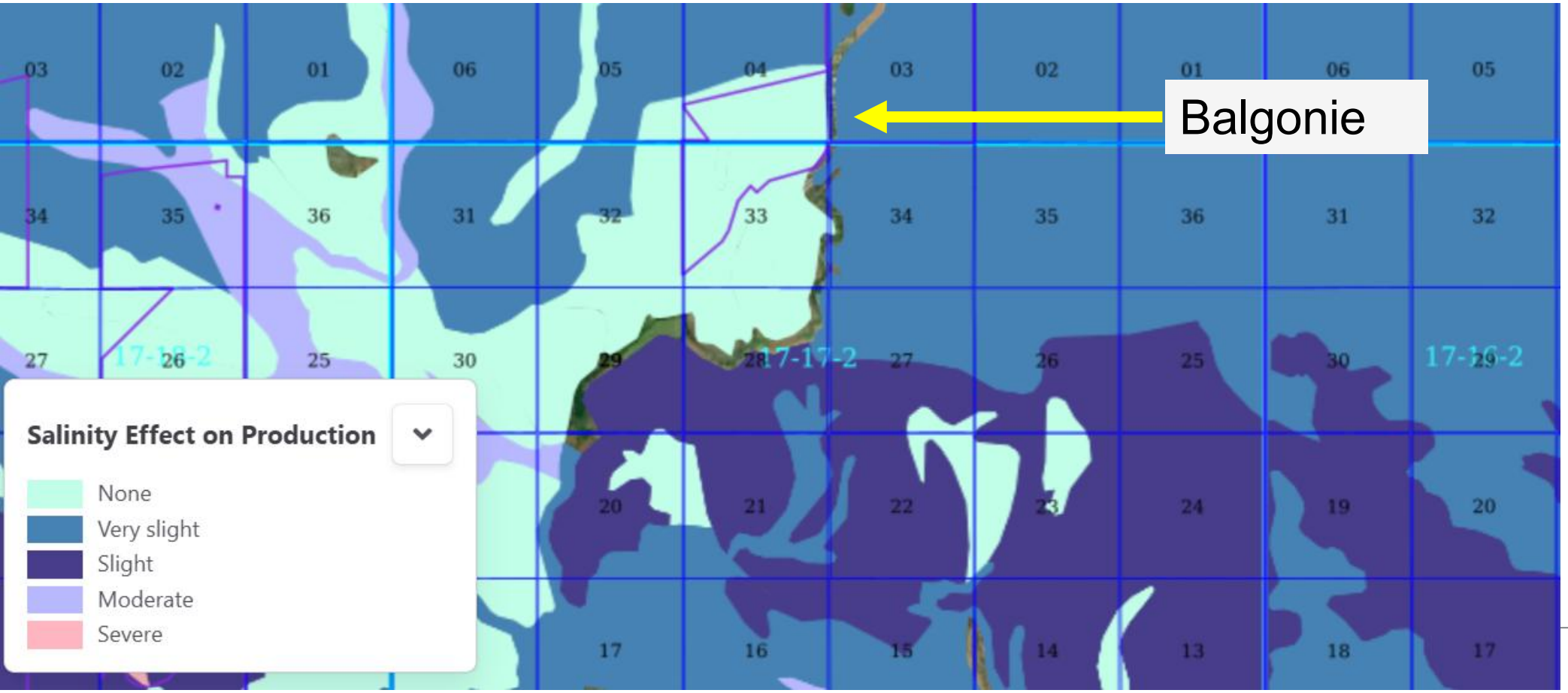
Moderate =
8 to 16 ms per cm

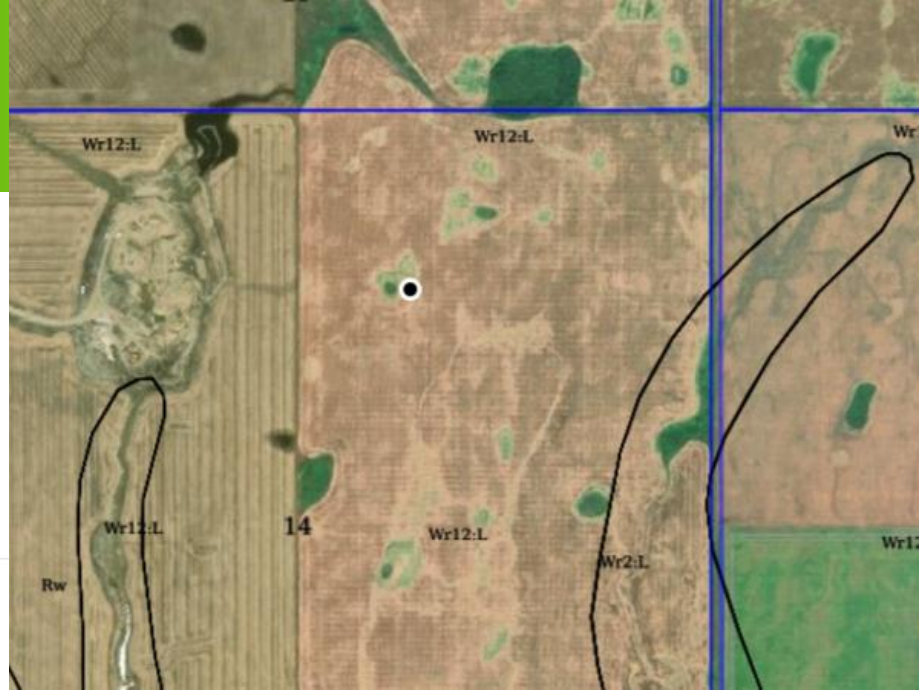
Severe =
> 16 ms per cm

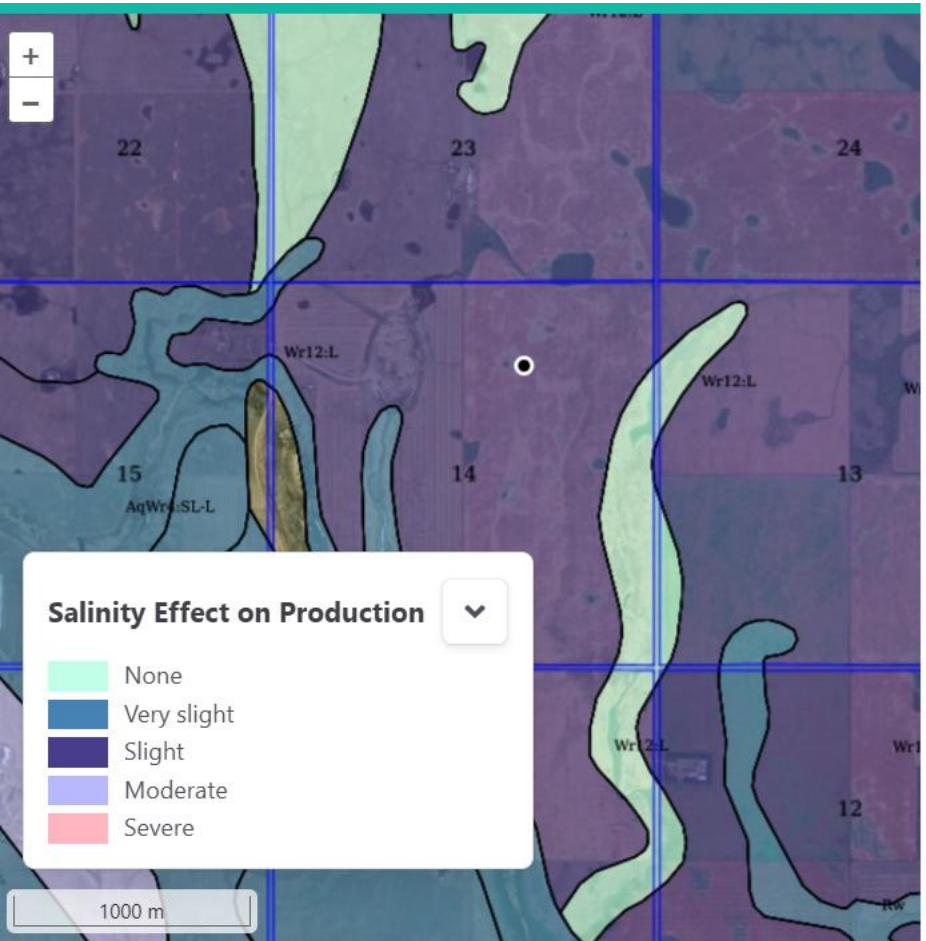
Saturated Paste



FOOTNOTES


Balgonie
Salinity Effect on Production
None
Very slight
Slight
Moderate
Severe





Polygon | Map | Component

Polygon ID: SKDSSREG0220

Polygon Label: Wr12:L3h2

Mainly orthic Weyburn soils, with calcareous Weyburn soils on upper slopes and knolls.

WEYBURN: Dark Brown Chernozemic soils formed in loamy glacial till.

Surface Texture: Loam

Slope Description: GENTLE SLOPES 2 - 5% (CLASS 3)

Surface Expression: HUMMOCKY (h)

Salinity Class: 2MP

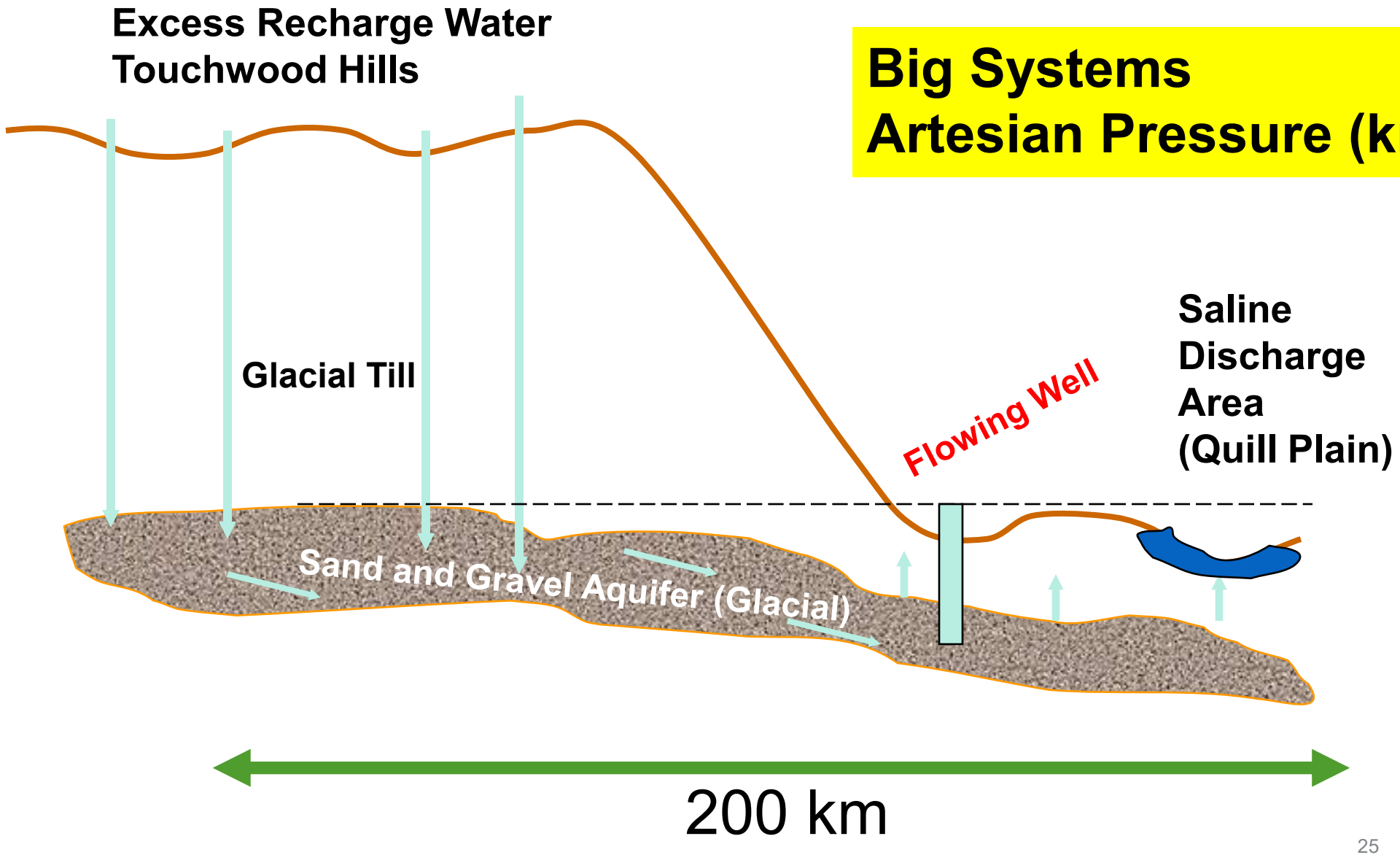
Salinity affect on productivity: Slight

Ag Capability:3(10)M

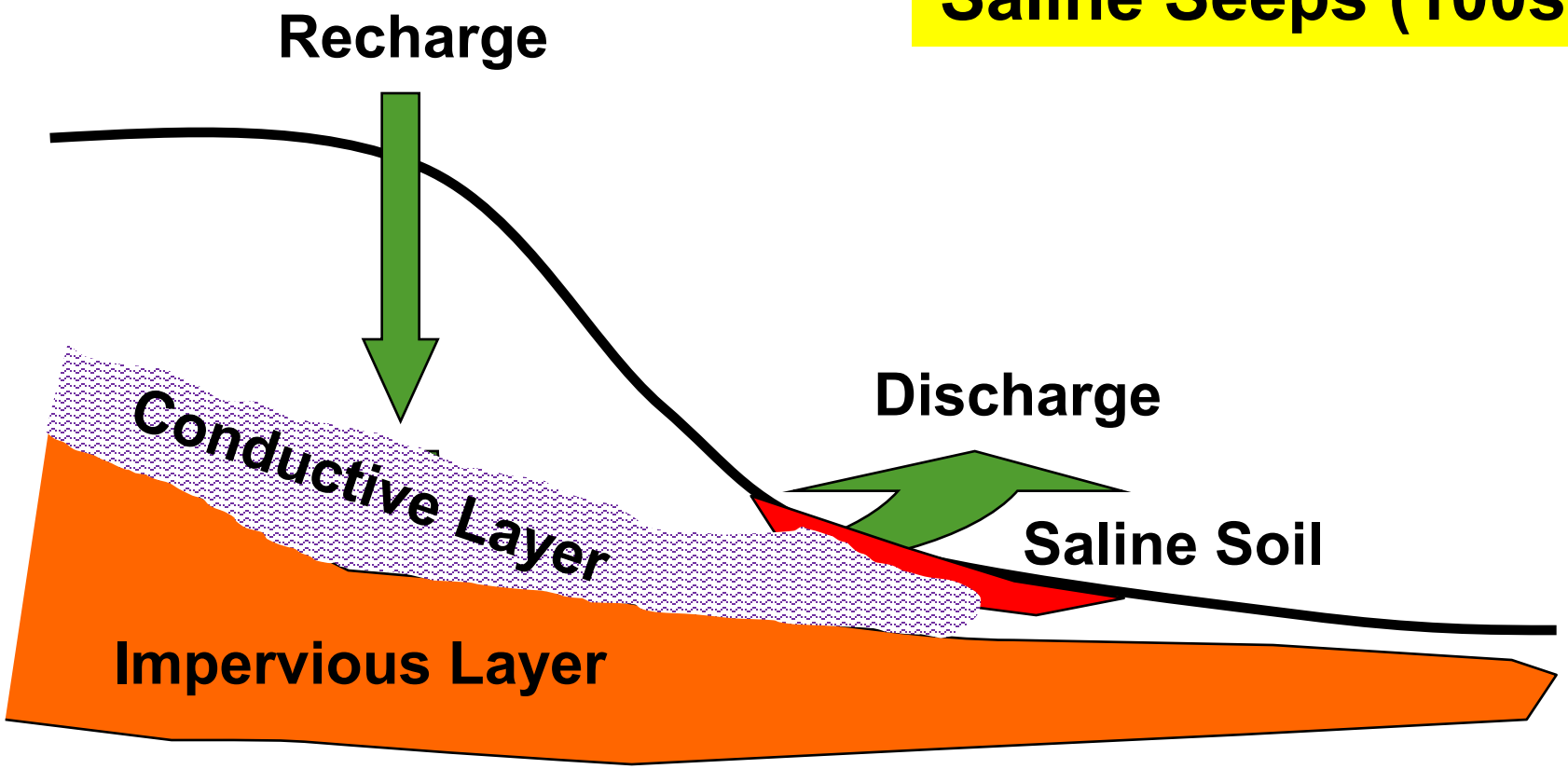
100% class: 3
Moisture limitations.

Soils in this class have moderately severe limitations that restrict the

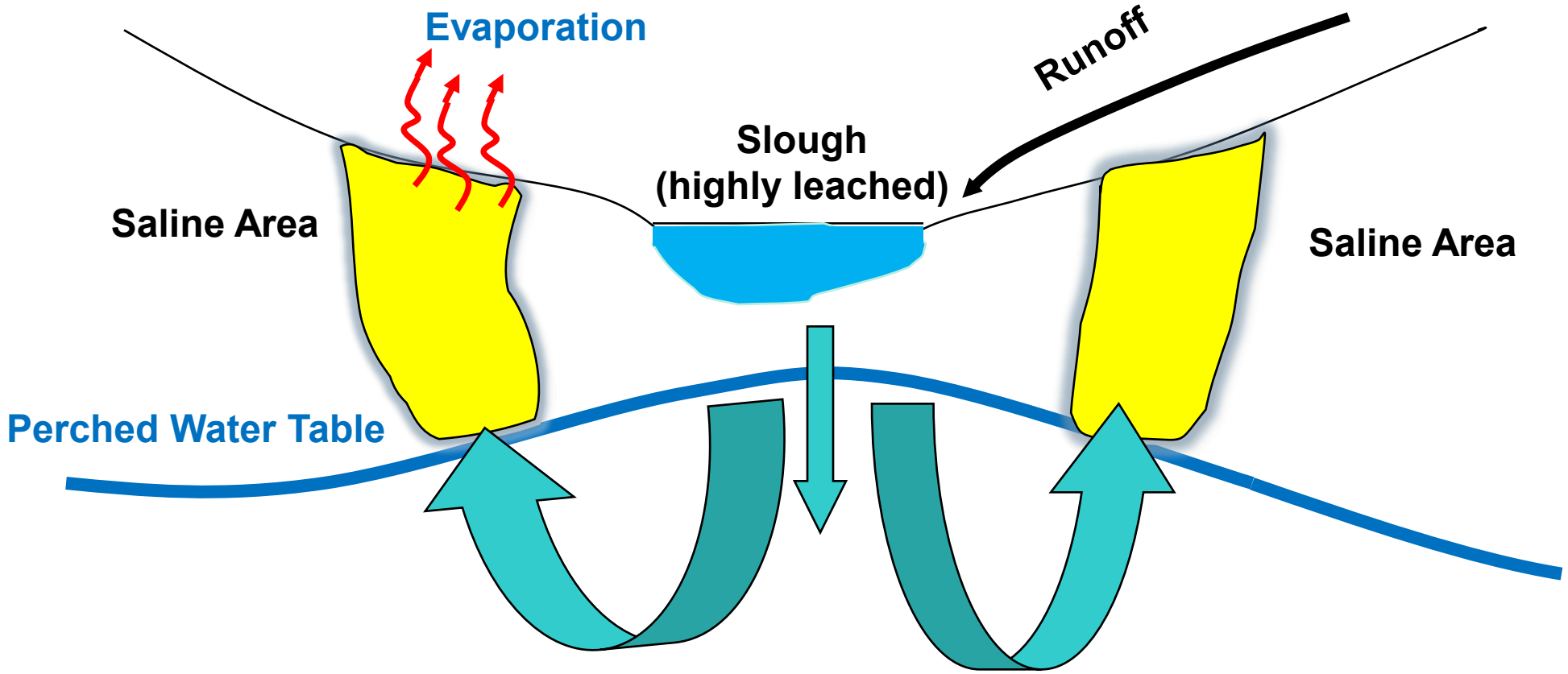
Saline Systems – Its all about ground water movement



Medium Systems
Saline Seeps (100s of meters)



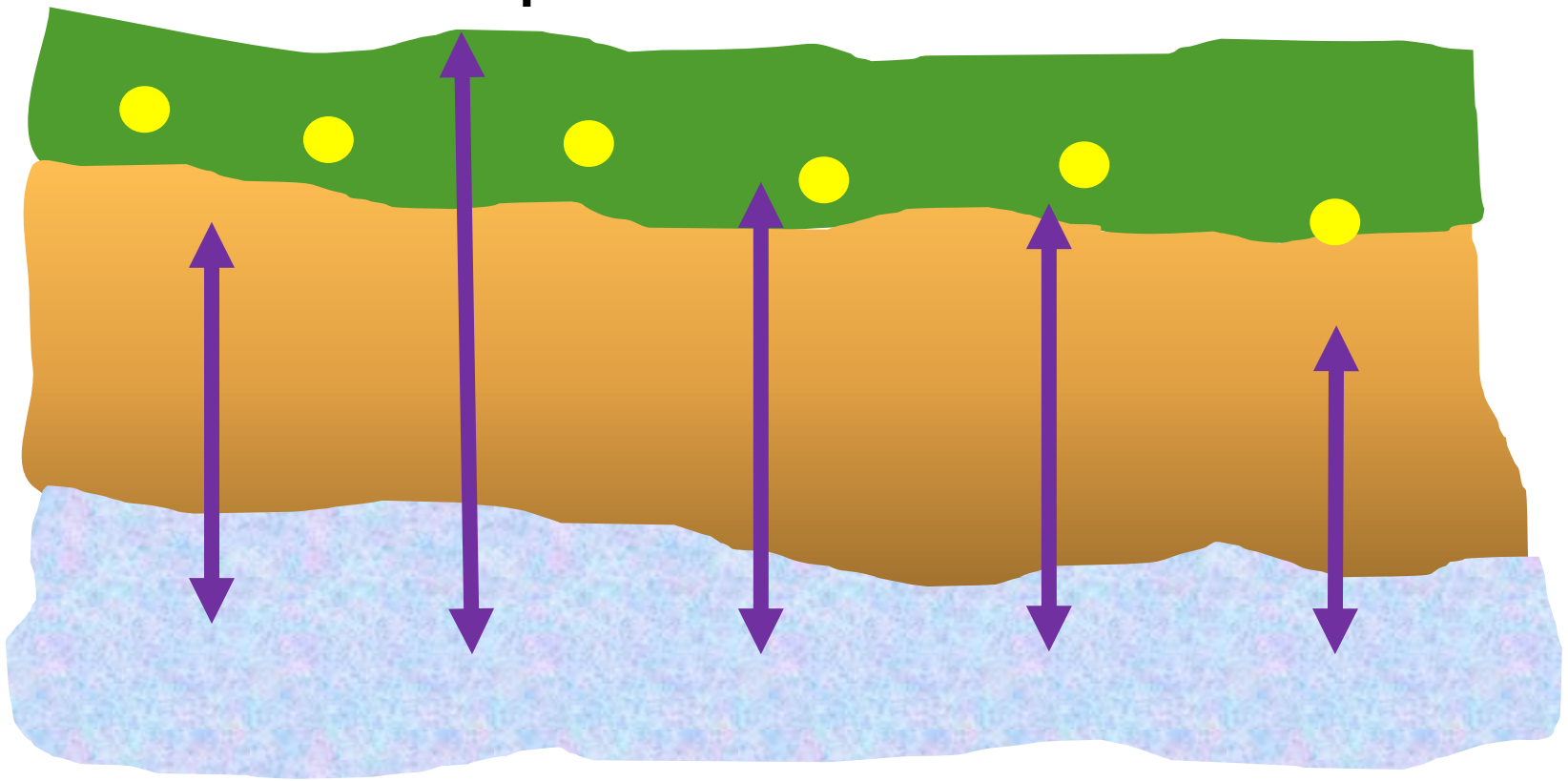
Small Systems
Evaporitic Rings (meters)
sloughs, lagoons, ditches

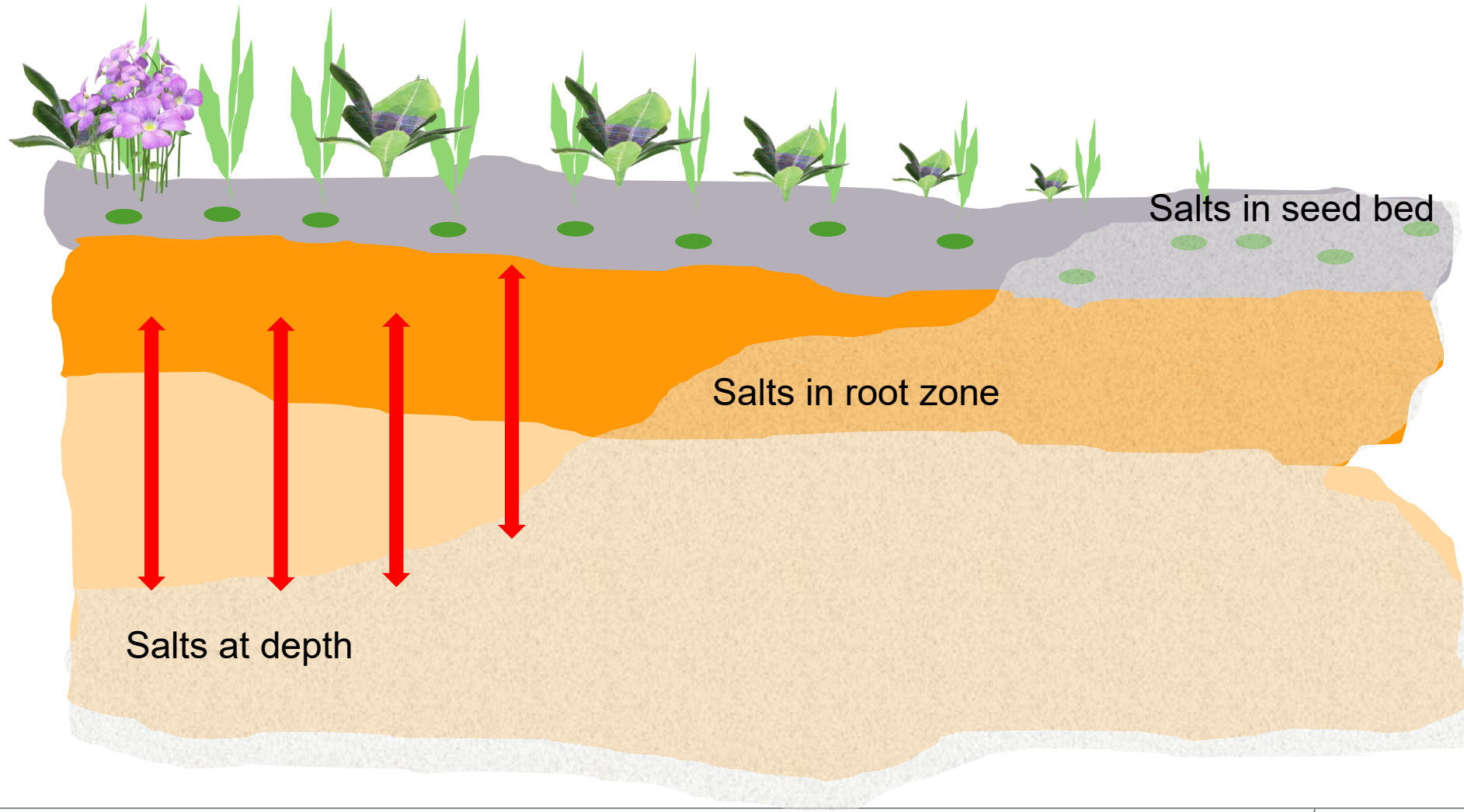


Salt Depth is Key to Annual Germination

Wet year(s)…Create high Water and Salt Table….
Dry Spring….Water and Salts Rise to seedrow…

Annual Crops become an Annual Headache





Germination?

Water and nutrient access?

Managing salinity

Please Remember….

pH and salinity are NOT related

Lime will not ‘fix’ salinity

Gypsum will not ‘fix’ salinity nor acidity

There are no miracles in soil science.

<u>Salinity management – ground water and crop management</u>

Cures for salinity?

- a loam soil with moderate salinity has over 8 tonnes of salt per acre to 2 feet.
- Try keep the salts out of the root zone
- Eliminate fallow and tillage
- Remove water with subsoil tile drainage...leach salts out? But you need excess water to move through the soil
- **More efficient soil water use by plants (keep the salts down deep)**
- **Tolerant forages**

Forage Options – look for **tolerance, yield and palatability**

1. Alfalfa is great for taking up soil water, if you can get it established. Sweet clover is the legume second choice.

2. AC Saltlander Green Wheat Grass
   = Blue Bunch Grass x Quackgrass

   Good palatability and grazing potential.

3. Tall and Slender Wheatgrass quite good, less palatable.

When to seed?

Alfalfa Kochia

How Does Salinity Affect Weed Biology and Control?

1. Weed spectrum - some weeds can tolerate more salts than other weeds or the crops we grow - kochia, Russian thistle, foxtail barley

2. Saline areas become a seed source of weeds and herbicide resistance (kochia)

We will not spray our way out of a kochia problem if we do not deal with salinity.

Salinity x kochia x chemfallow = G9 Resistance

A side effect of farming marginal soils….

Lots of seed. And lots of herbicide tolerant seed.

Kochia – tumbles
Foxtail barley – wind and equipment

Nutrient Management in Saline Landscapes

For example, salinity leads to variable N supply AND variable yield potential….

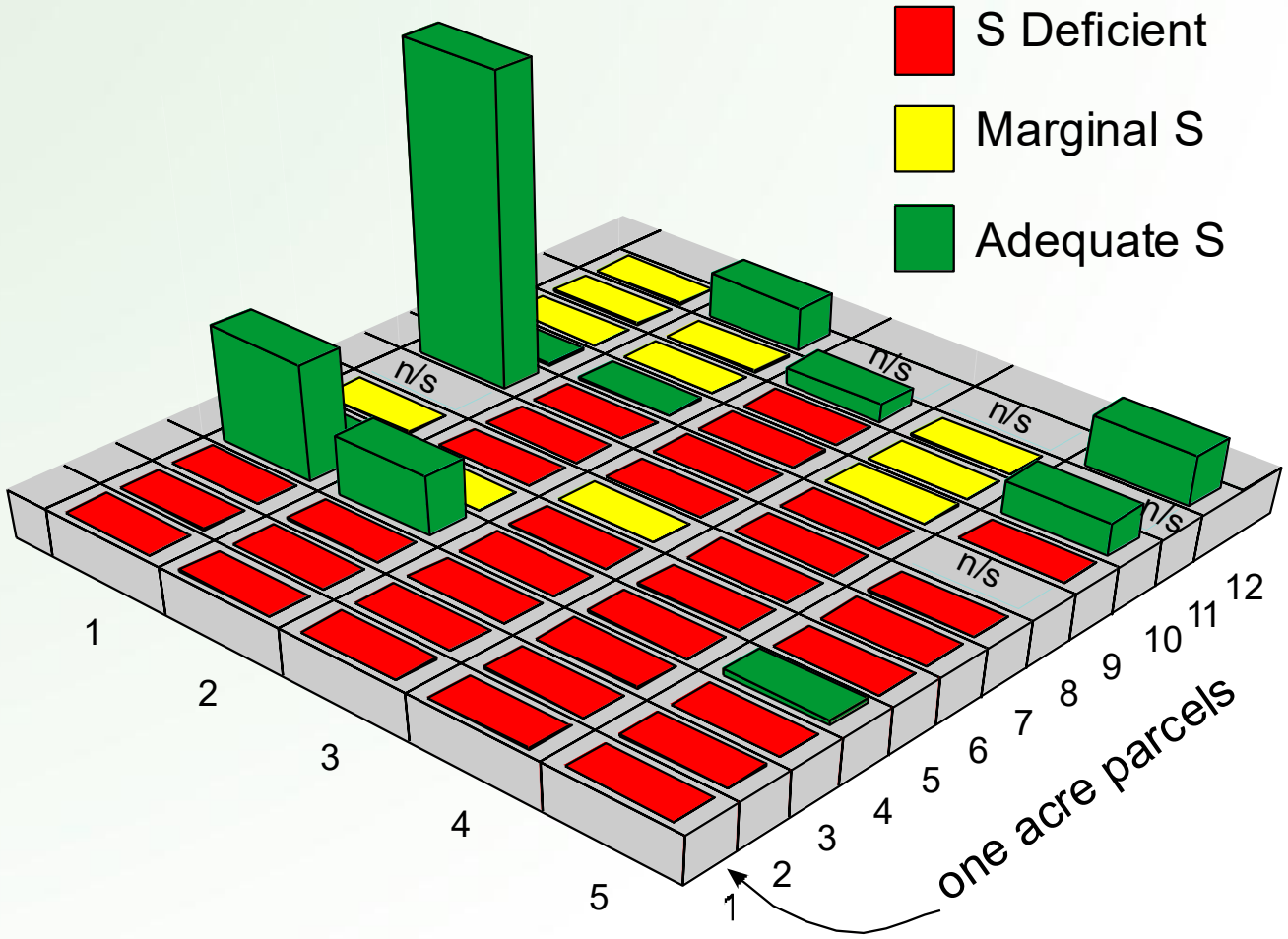
- Sulphur. 1000s of lbs of sulphur. A gift to VR fertilizer.
- Of note – even slight salinity will involve 100s of lbs of sulphur.

- N and P accumulation in saline areas (residual fertilizer, ground water, erosion accumulation)

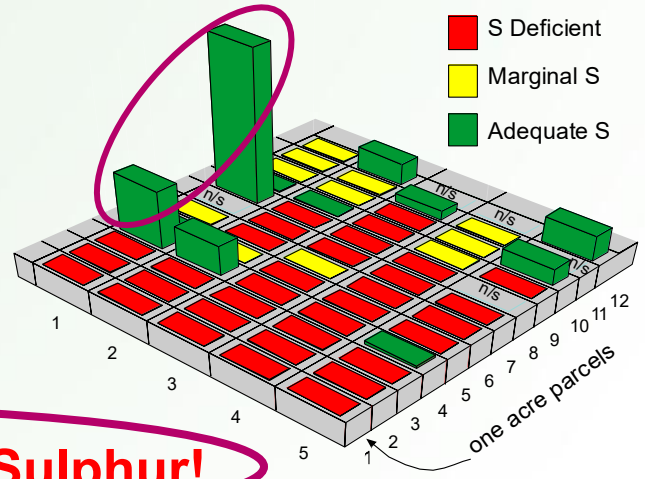
- However – limited root growth, high osmotic potential – P and K

- Salinity limits water, limits yield, limits N response – adjust target yields.

Sulphur in a saline field is super duper variable



What happens if:	SO4-S (lb/ac)
Average of all 60 samples	262
the most extreme high value was removed	142
the 2 most extreme values	98
the 5 most extreme values	36
the 6 most extreme values	22
the 8 most extreme values	11



90% of area was deficient in Sulphur!

The ‘top 2’ averaged 3800 lb S per acre!
Soil Testing is **NOT** ‘Wrong’. But it is an average.

Accepting reality

Spending money on bad soil…what to do?

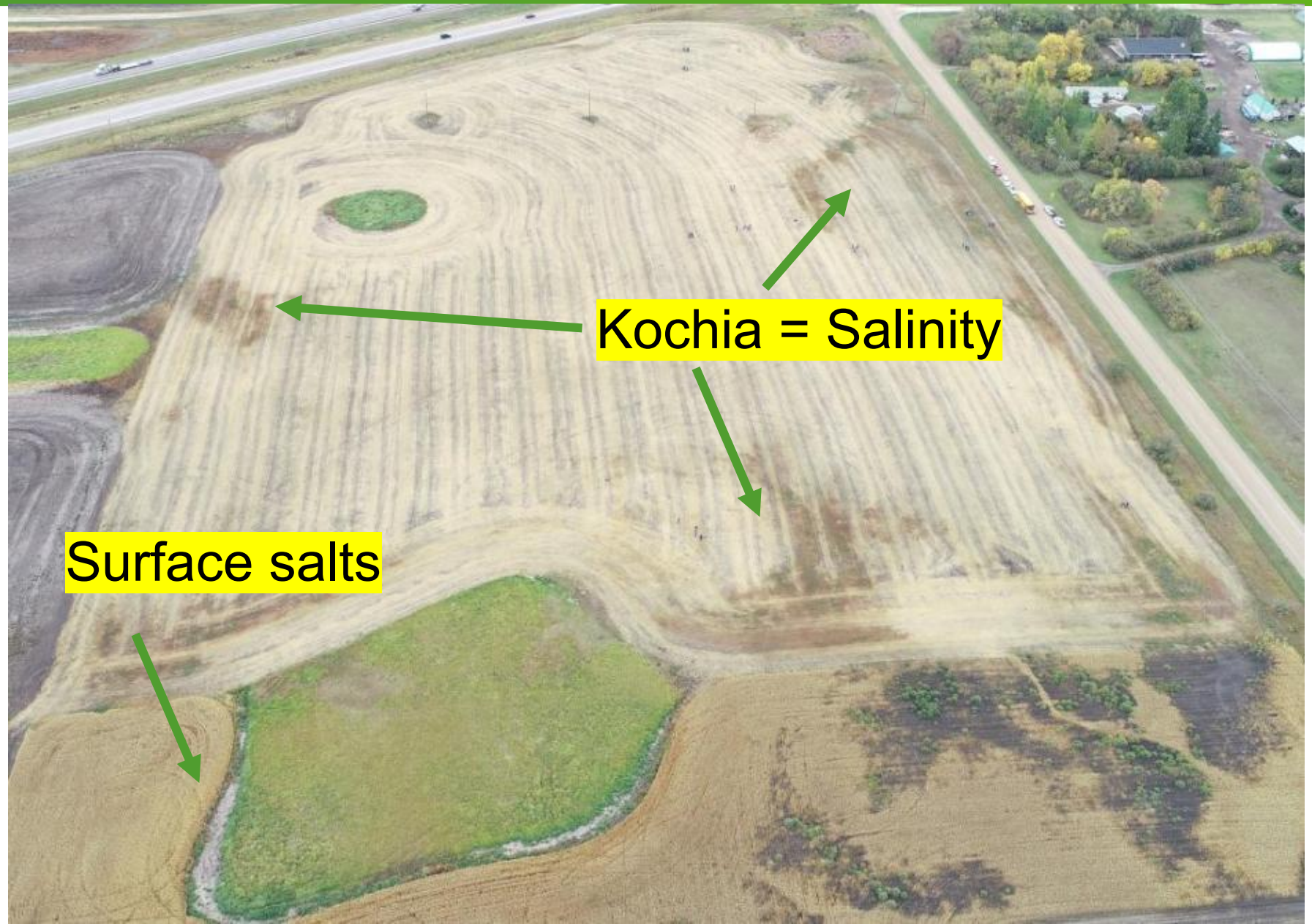
Some areas would be easy to manage – some not

A ‘Case Study’ – USask Goodale Farm

Dark Brown Soils, Sandy Loam
Soil pits, Drone images, NDVI images, Soil Tests

Mid Slope
A = 15 cm, lovely profile

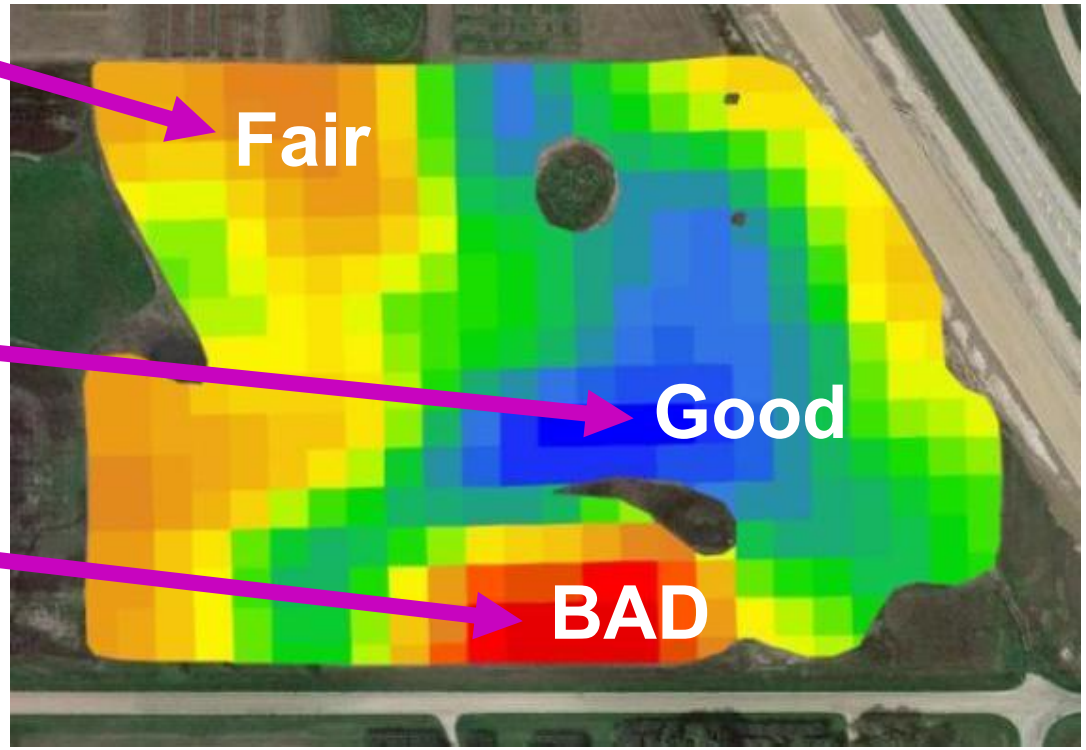
Tell tale signs of salinity



FOOTNOTES

Layered NDVI……basically a soil x biomass map

Some areas of this field have performed relatively poorly for multiple years, indicating a soil issue



Sampling the field by team

Soil ‘Chemistry’ to 12”

Sample Location	pH (1:1)	EC (1:1) ms/cm	Salinity ‘Rating’
Red	8.2	4.7	Severe
Orange/Yellow	6.9	2.6	Moderate
Green	7.6	2.3	Moderate
Blue	7.8	1.0	Slight
“Random”	6.8	0.8	Nonsaline

‘Available’ Nutrients (‘lb per acre’)

Sample Location	NO3-N	P	K	SO4-S
Red	42	142	1100	>800
Orange/Yellow	66	106	1772	>800
Green	20	45	1467	560
Blue	6	154	3496	30
Random	24	61	1178	442

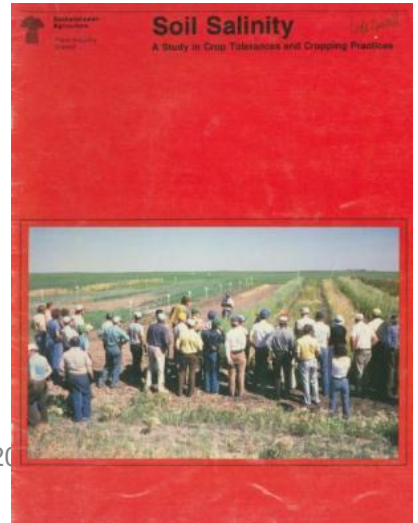
More N and P in Saline Areas…..Why?

Yield Potential: yield in this field is driven by salinity

Sample Location	EC (1:1) ds/m	EC (SP) ds/m	Salinity 'Rating'	Yield loss %
Red	4.7	11.3	Severe	83
Orange/Yellow	2.6	6.2	Moderate	32
Green	2.3	5.5	Moderate	25
Blue	1.0	2.4	Slight	0

Based on Spring Wheat Yield % (if Sat EC is >3) = -10 EC (saturated paste) + 100

Holm, H.M. 1983. Soil Salinity.
A Study in Crop Tolerances and Cropping Practices.



N Fertilizer ('lb N per acre'): Soil test x Yield Potential

Sample Location	Yield Potential bu per acre	Sample Depth	Soil NO3-N	Fertilizer N
Red	10	0-12"	42	**0**
Orange/Yellow	38	0-12	66	**5**
Green	42	0-12"	20	**56**
Blue	60	0-12"	6	**103**
Random	50	0-12"	24	**67**

N rate = soil test (supply) and yield potential (demand)…..

If we applied N by 'Random' soil test, we may always be wrong

Too much N or not enough N is BOTH bad for the farmer and the environment

Income also variable per area

Sample Location	Yield Potential bu per acre	Income	Net Income
Red	10	$80	**- $270**
Orange/Yellow	38	$304	- $46
Green	42	$336	-$14
Blue	60	$480	$130
Random	50	$400	$50

Money lost on poor land. Yield and money lost on good land.

Move that money to the best land. Make more money.

You could also change crop choice

Crop Species	Yield Loss %
Spring wheat	83%
Canola	89%
Barley	50%
Alfalfa	39%
Smooth Brome	17%
Green wheatgrass	2%

The annual crops? High cost, negative income, lead to more salinity if not a success

Forage crops? Moderate cost, low income, may reduce salinity in surrounding area

Case Study 2 – Extremely saline sloughs

‘Slough 1’ EC/SAR 0-15”

FOOTNOTES

April 2019 to June 2020 – Saltlander grass

Summer 2020 – Saltlander blend - Bales!

Salts still present, but tolerated

Bales!

I write a newsletter…..

AGRONOMIC BULLETIN

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Overall…

- Soil is variable
- Yields are Variable

- In some cases, we should vary inputs, or try improve lower yielding areas.

- In some cases, we should vary land use

A win for the farmer.
A win for the environment.
A key to the climate conversation