

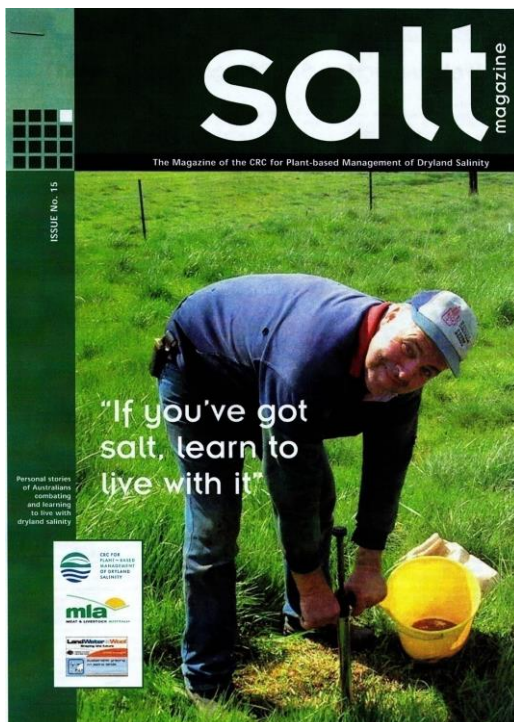
Q and A: Soil salinity and sodicity

Soil and Soil-Water Workshop

Dr. Tom DeSutter

NDSU, Dept. of Soil Science

January 19, 2022



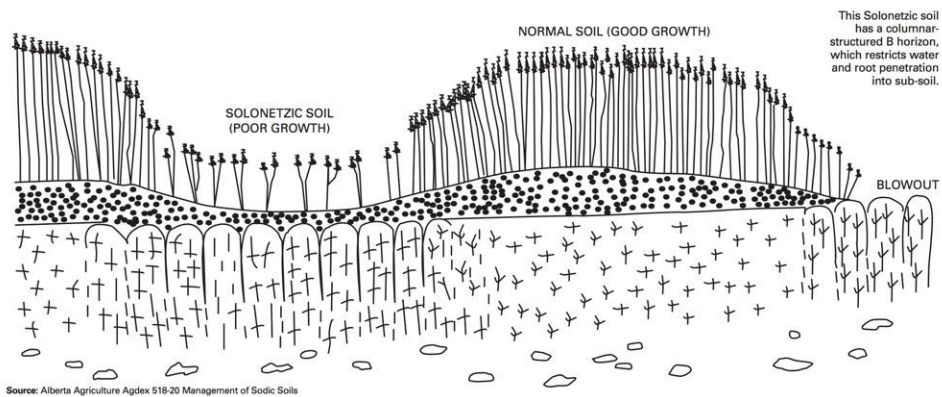
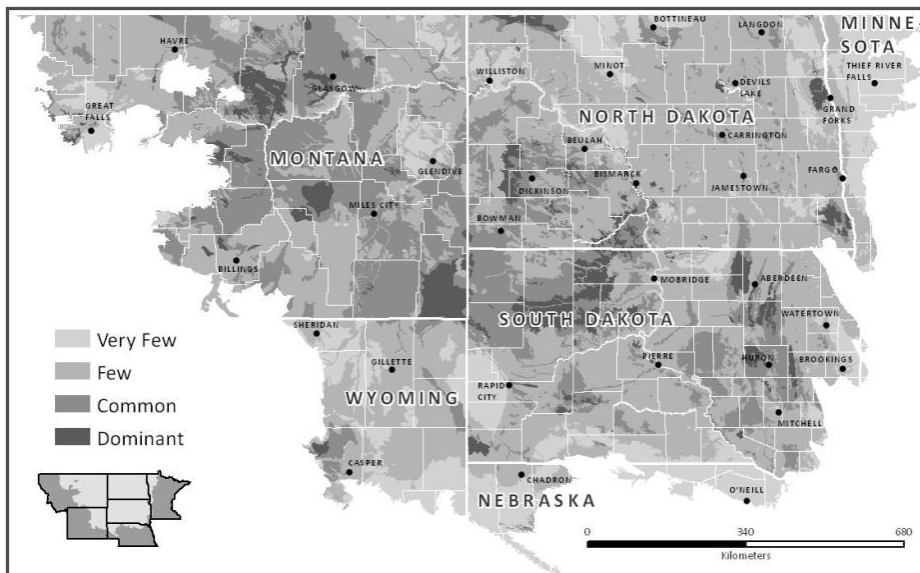
Why Q and A?

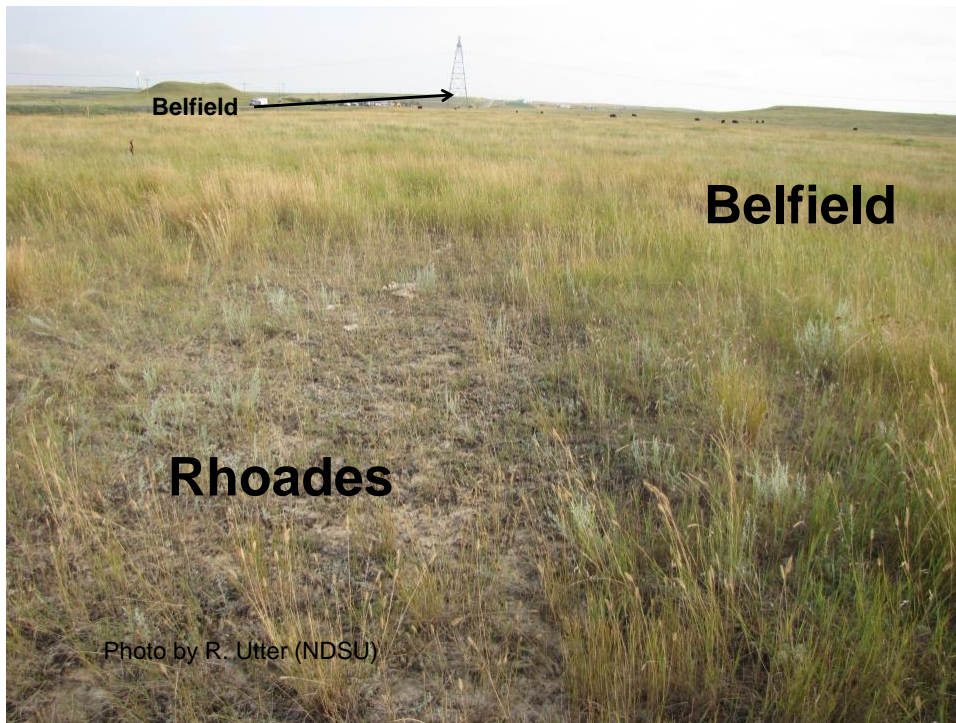
“Saline” vs “Sodic” Soils

- **Saline soils**
 - Contain elevated levels of the of the Chloride and Sulfate salts of Na, Ca, Mg, and K
 - Salinity is the “total concentration of dissolved mineral solutes that are found in waters and soils” (NRCS)
- **Sodic soils**
 - Soils affected by the sodium ion (Na^+)
 - Sodicty is the “accumulation of sodium”
 - Most times have low salinity

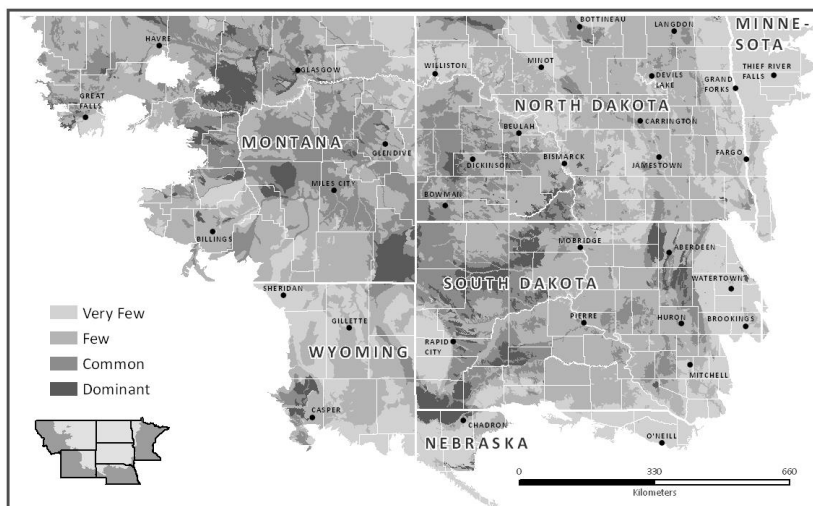


Saline soils, EC > 4 dS/m (in ND about 5.8 million acres)





Sodic soils, $\text{SAR} \geq 10$; 4,730,000 acres in North Dakota





Water Management

Salinity is a water management problem
-too much vs too little
-salts dissolve into ions, ions move with the water

“Common” Salts in the Soil

Compound	Common Name	Molecular Formula	Solubility (20° C)
			g/L
→ Calcium carbonate	Lime	CaCO ₃	0.06†
Magnesium carbonate		MgCO ₃	2.51‡
Sodium carbonate	Soda	Na ₂ CO ₃	179
Sodium bicarbonate	Baking soda	NaHCO ₃	87
→ Calcium sulfate	Gypsum	CaSO ₄	1.9
Magnesium sulfate	Epsom	MgSO ₄	252
Sodium sulfate	Glauber's salt	Na ₂ SO ₄	161
Magnesium chloride		MgCl ₂	410
Sodium chloride	Table salt	NaCl	264
→ Calcium chloride		CaCl ₂	427

Where do the ions come from?

- Na⁺, K⁺, Ca²⁺, Mg²⁺, Na⁺, Cl⁻, SO₄²⁻, CO₃²⁻, HCO₃³⁻
- Dissolution of secondary minerals
- Concentration in soil depends on the secondary minerals and their parent salts' solubility

“Long term approaches to reclaim saline land within the prairie pothole region?”

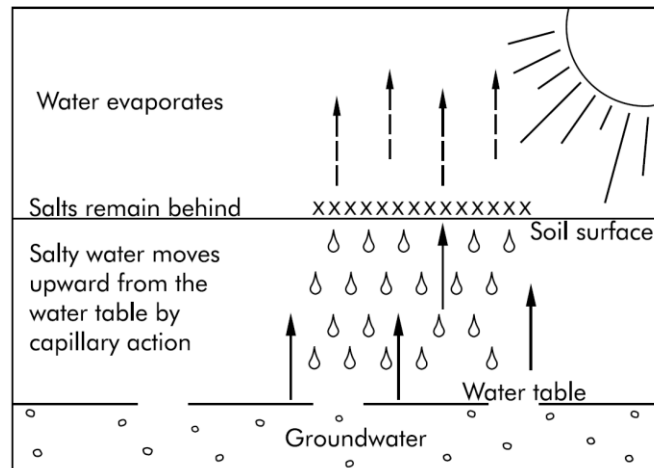


Figure 2. Salts build up by capillary action and evaporation

Revised January 2010

AgNet R28-12

**Dryland Saline Seeps:
Types and Causes**

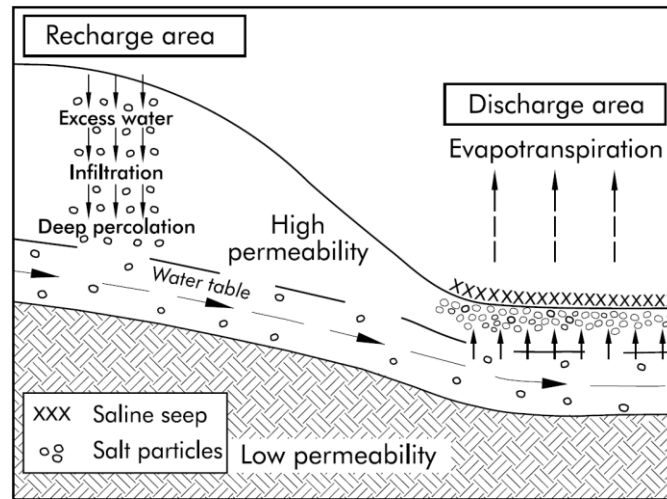


Figure 1. Generalized saline seep formation

Salt-tolerant grasses in the saline area and alfalfa in the upslope dominant recharge area

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AgInfo 6/08/12

Dryland Saline Seeps: Types and Causes

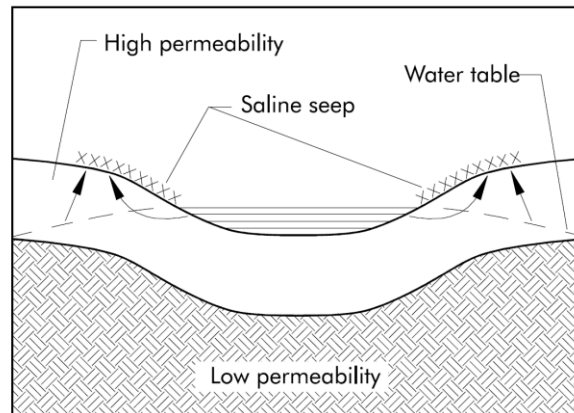


Figure 8. Slough ring salinity

Salt-tolerant grasses in a band around the slough in the visibly saline area and extending an additional 20 to 60 m beyond;
appropriate surface water management

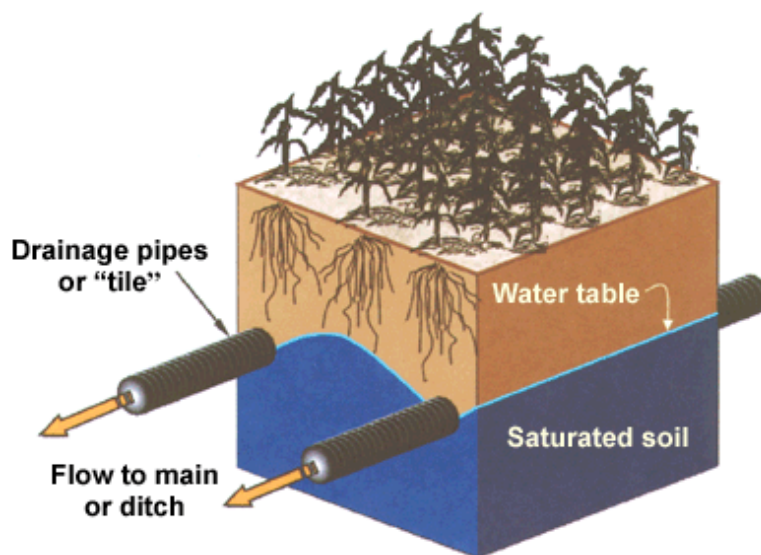
(60 to 200 ft)

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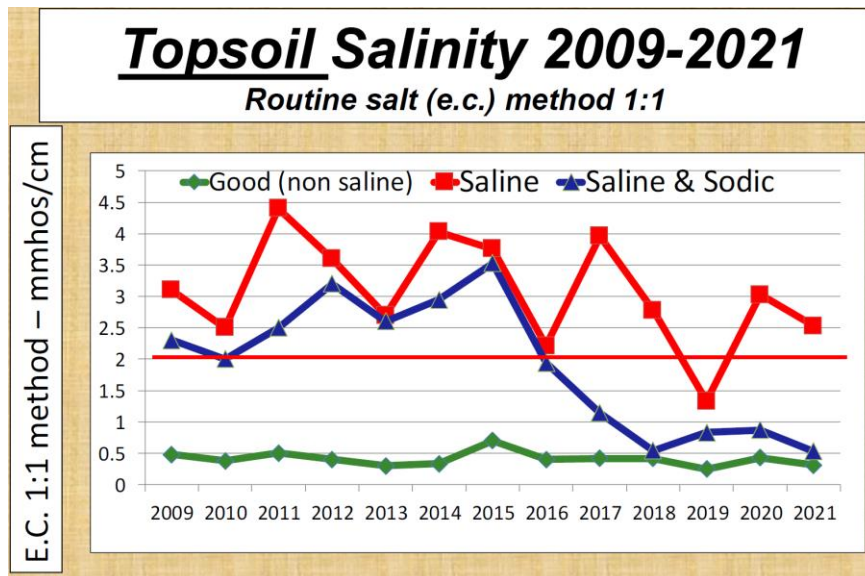
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Dryland Saline Seeps: Types and Causes

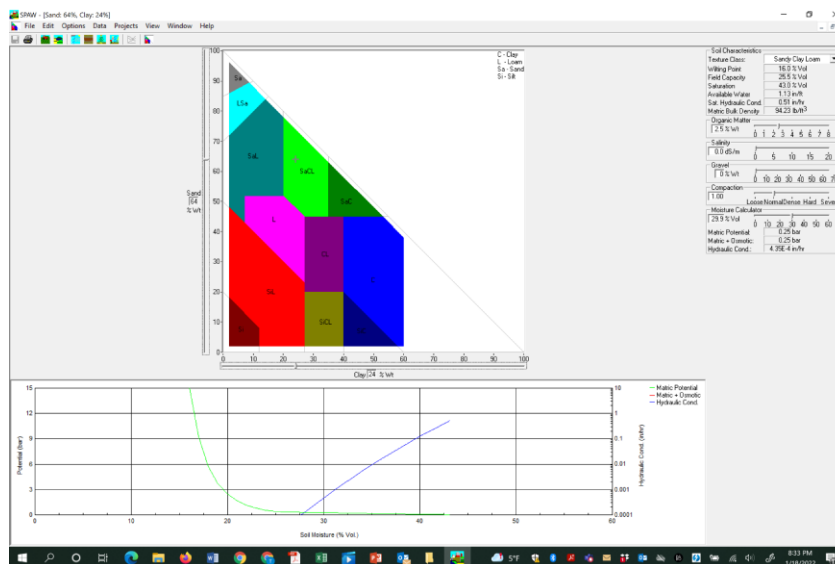
“What can be done to enhance salt leaching to tile lines?”



<http://www.extension.umn.edu/distribution/cropsystems/images/7740f04.gif>



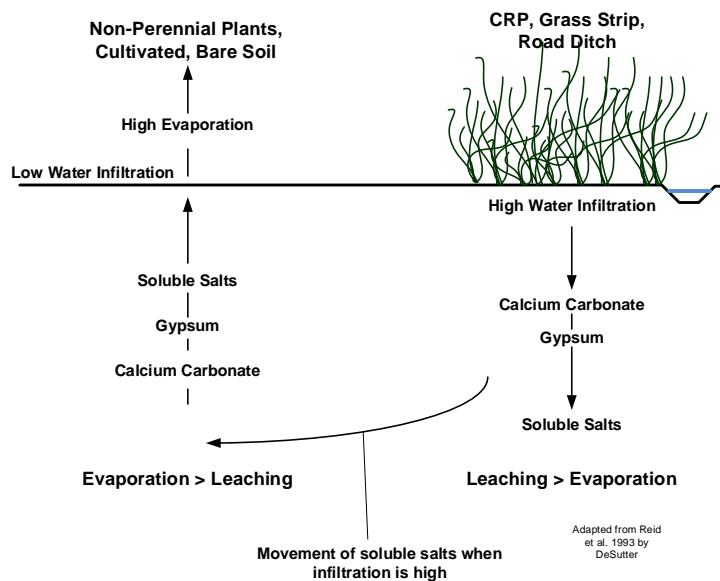
J. Lee, Agvise

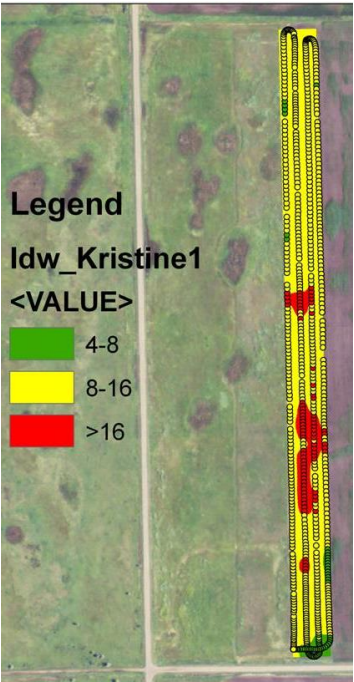
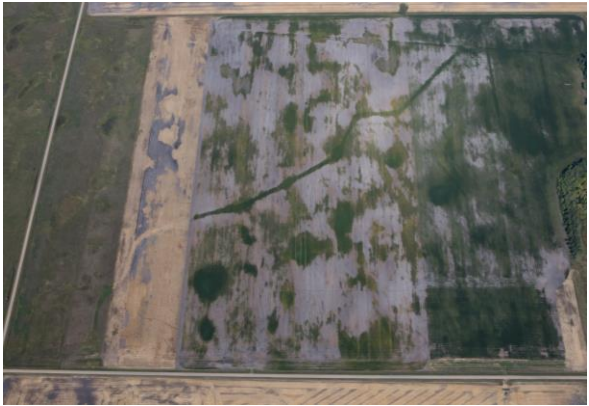


Sort of tiling example...



Evaporation?
Salts' solubility?
Time?
Aggregation?
Water sources?





Field Day, Grand Forks Co, 2014

400 ft

700 ft

Road

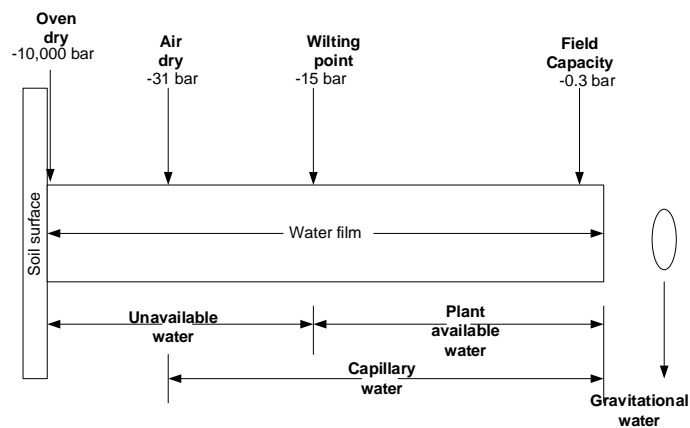
CRP

Cultivated Field

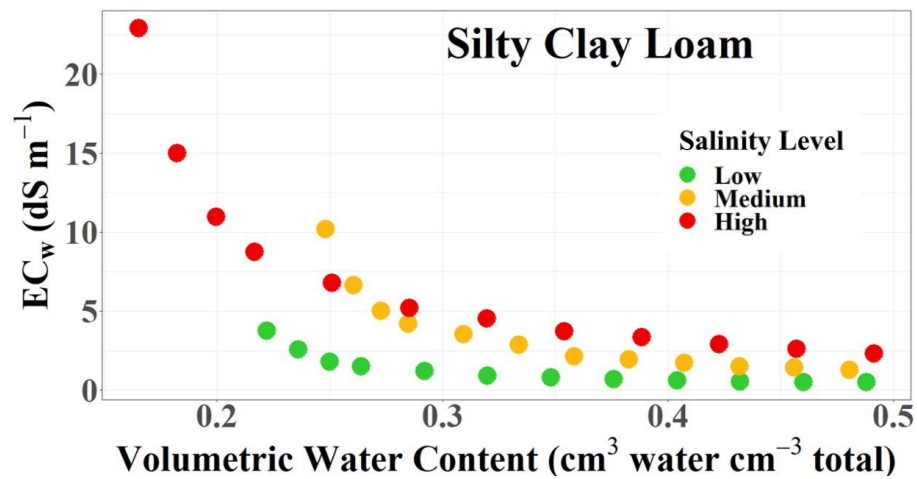
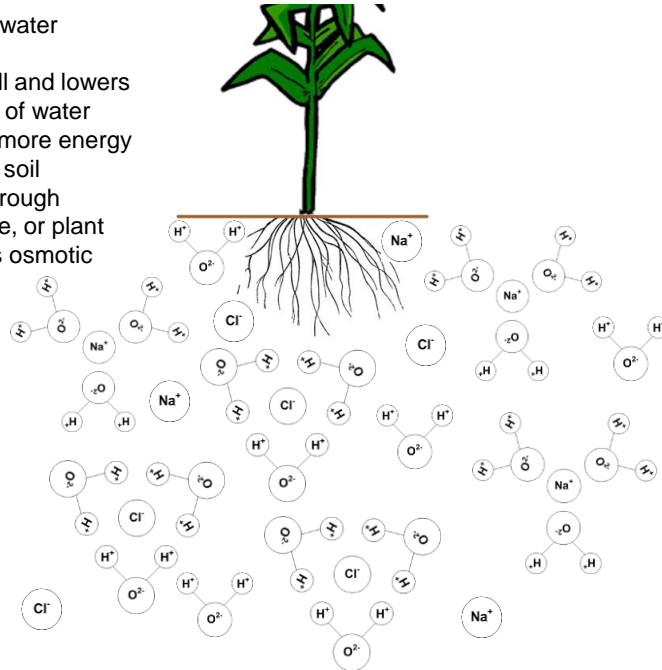
0-6"	3.0	3.3	3.7	4.3	13.1	14.2	8.4
6-12"	3.7	4.7	4.5	6.1	6.4	6.7	6.1
12-24"	3.7	4.1	4.4	6.0	5.4	5.4	5.4
24-36"	3.9	4.6	5.2	5.9	5.5	5.1	5.5
36-48"	4.1	4.9	5.9	6.5	6.1	5.3	5.0

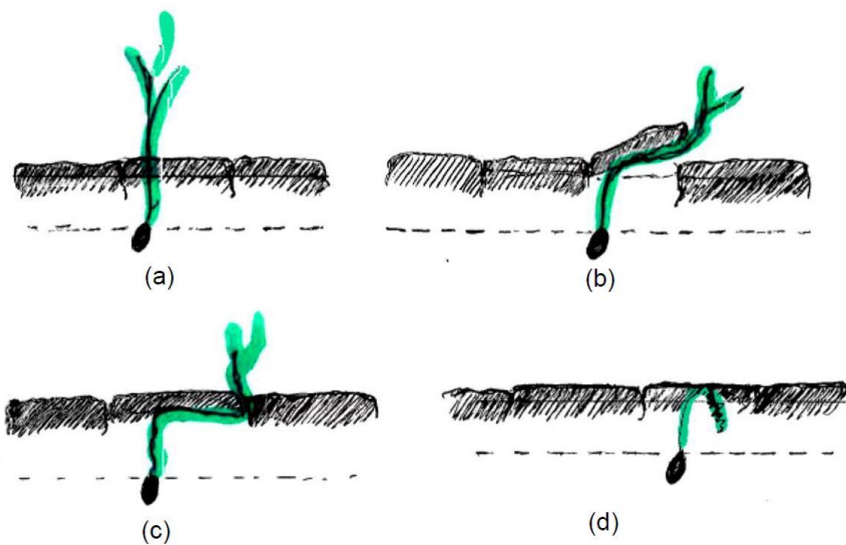
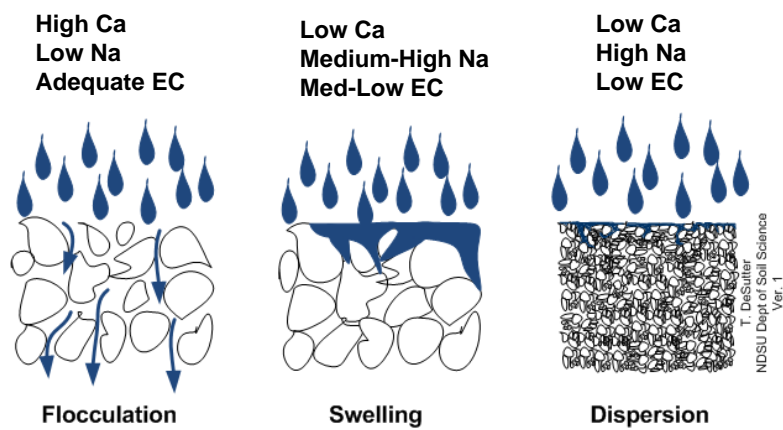
DeSutter and Wick
Ver 1

“How does drought affect salinity and sodicity?”



1. Ions have affinity for water molecules
2. Forms hydration shell and lowers the osmotic potential of water
3. Plants have to exert more energy to extract water from soil
4. Depletion of water through evaporation, drainage, or plant uptake further lowers osmotic potential.





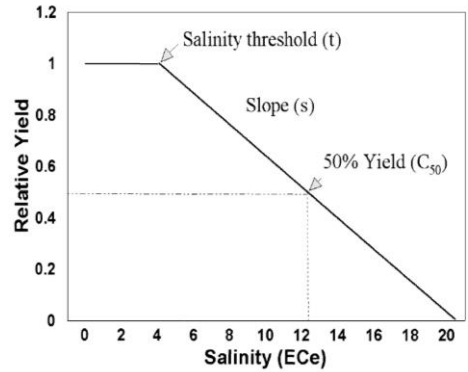
<https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/understanding-the-physiological-basis-for-improved-wheat-seedling-growth-on-dispersive-sodic-soils>

“Is there a chart for threshold salinity values for cover crops? Specifically turnips and radishes?”

Soluble Salts and Plants

- **Salinity has three potential effects on plants**
 - 1. lowering of water potential
 - 2. direct toxicity of any Na^+ and Cl^- absorbed ions
 - 3. interference with the uptake of essential nutrients

M.C. Shannon, C.M. Grieve/*Scientia Horticulturae* 78 (1999) 5–38



Salt tolerance parameters relating relative yield to increasing salinity in the root zone.

14

M.C. Shannon, C.M. Grieve/*Scientia Horticulturae* 78 (1999) 5–38

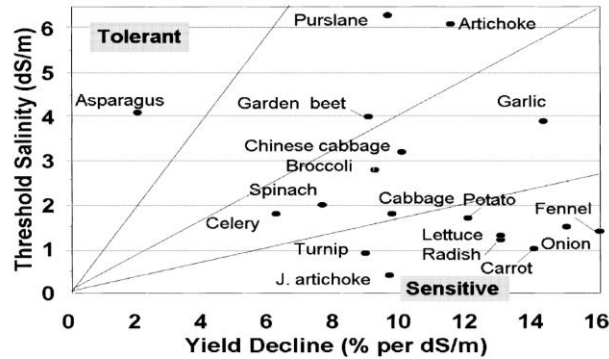
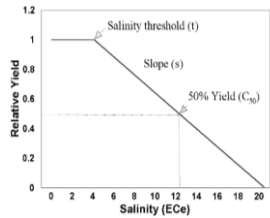


Fig. 2. Salt tolerance of several vegetable species as rated by the salinity threshold and percent yield decline.



“The dry conditions have lowered the water table in 2021 significantly. Do you anticipate it will reduce salt levels if we have normal precipitation this spring?”

The solubility of salts deposited at soil surface and worked in by tillage related to time it takes for them to move out of the root zone after tile drainage or in non tiled fields. Also in relation to the movement of salts, how does no-till differ from conventional tillage, and include deep ripping, with respect to tile and non tile situations. The question would relate to a salt/sodic spot in a field. I tile it, and want to get rid of one or the other or both. Include cover crops, CRP, trees in the discussion. look at long term (generational, I'll do it for my grandkids) to short term, I want more yield next year.

Don't expect tile to always work



Formula	Solubility (20° C)
	g/L
CaCO_3	0.06†
CaSO_4	1.9
MgSO_4	252
Na_2SO_4	161

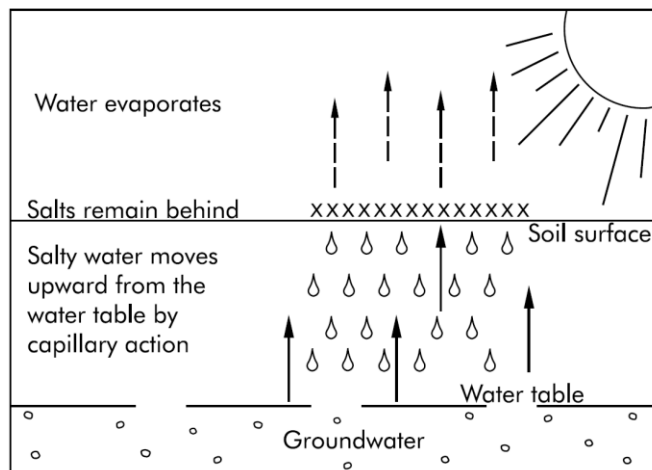
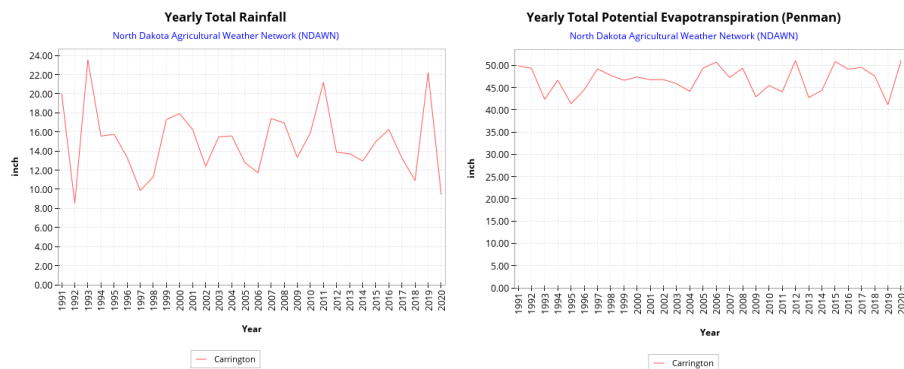
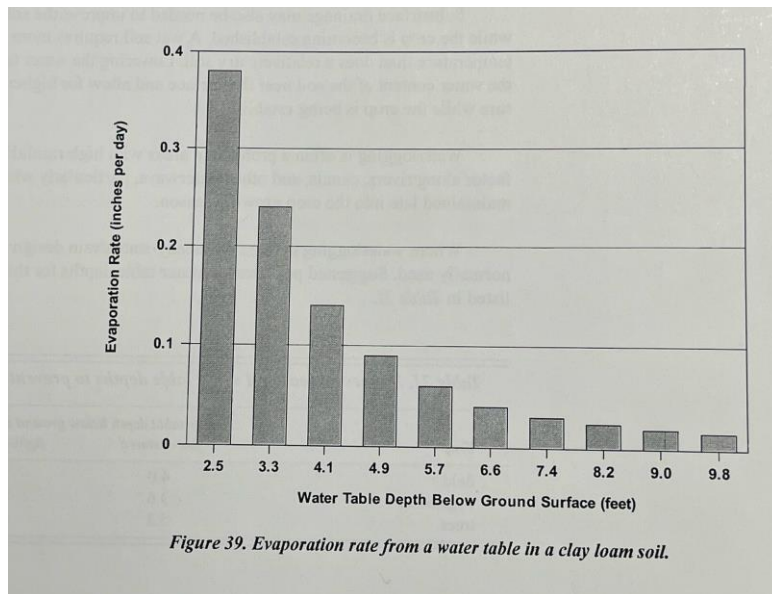


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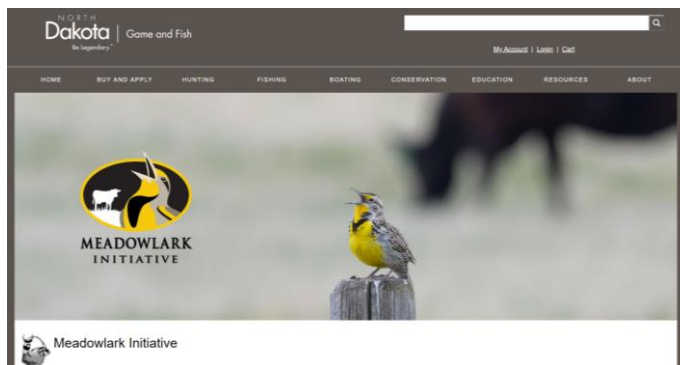
*Division of Agriculture and Natural Resources
 Publication 3375
 University of California Irrigation Program
 University of California, Davis
 Revised 2006*

What is the ultimate solution to gaining back land we have lost to salinity & sodicity? Is there an “easy” button like so many farmers believe there is?

Grow you way out of it?

- Planting forages or cover crops allows for ground cover, introduction of carbon, water use, and improved soil structure.
- Choosing tolerant crops that keep one from losing revenue
- May be the only viable option for high salt soils
- Having livestock in the operation helps
- If not, try to find an outlet for the hay

Explore alternative land uses



“The program allows producers to plant marginal cropland back to diverse native perennial grasslands for grazing. Funding is available to establish the grass and to install grazing infrastructure, such as fencing and water. Producers also are eligible to receive rental payments for the first three years as the land transitions from cropland to grazing land.”

-Bismarck Tribune

Rapid time...

- Will the salinity spots decrease with increased rainfall?
- Is there research for planting native forbs in saline soils? Can we mitigate salinity and sodicity issues with amendments like biochar? Can techniques like remote sensing work to implement better saline/sodic management?
- When determining which crop to plant in a saline area, other than looking at pH and soluble salt levels, what other item(s) should you be looking at to determine which crop choice will be best?

Dr. DeSutter, pretend you were a second year farmer who has just purchased (on a 20 year bank note) his first quarter of land. This quarter has a five acre compacted saline headland. It also has two randomly placed five acre saline-sodic areas and one randomly placed five acre sodic area. Neither of the saline-sodic or sodic areas can easily be squared off along a field edge. This field is in central Cass County and is mapped 100% Fargo-Hegne silty clay. The field is flat, struggles with poor drainage on wet years, and would require a lift station for a drain tile outlet, if it were drain tiled. Economics pencil out best for corn or soybeans on the entire quarter. What kind of plan would you implement to improve your soil salt issues, while balancing the economics of farming?

DO: Crop Selection

DO: Manage water, figure out your drainage

Don't: expect tile to always work, especially short term

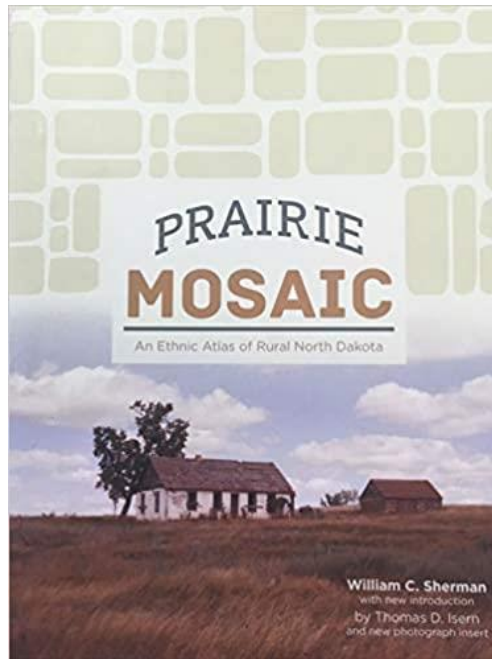
Don't: make soil black

Do: make sure ditches and culverts are clean

Do: make sure that CRP or idle lands are using water

Do: SOIL TEST!





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