Effects of Water Quality on Crops and Soil

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Effects of Water Quality on Crops and Soil

- **Outline**
  - **Background and Definitions**
    - ✓ **Salinity and Sodicity-What are They?**
    - ✓ **How do We Measure Them?**
  - **Four Rules**
  - **Seven Salinity Management Cornerstones**

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- **I. Definition and Measurement of Salinity**
  - **Defined simply as the total concentration of dissolved mineral solutes that are found in waters and soils**
    - These mineral solutes (dissolved components) are made up of specific chemical constituents or ions
      - ☑Major Ions: Calcium, Magnesium, Sodium, Sulfate, Chloride, Bicarbonate, Carbonate
      - ☑Minor Ions: Potassium
  - **Measurement**
    - Salinity is often expressed as a coalesced parameter representing the aggregated concentration of the dissolved minerals. This parameter which most people are familiar is either expressed as the electrical conductivity (dS/m, mmho/cm), or total dissolved solids (ppm)

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- **I. Definition and Measurement of Salinity *continued*:**
  - **Sodicity:**

Sodicity is described by the portion of the soil's total cation exchange that is occupied by sodium

- The Sodium Adsorption Ratio (SAR) of *soil solution* or *soil extract* is the primary parameter in describing sodicity

$$SAR = \frac{Na}{\sqrt{(Ca + Mg)/2}}$$

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- **I. Definition and Measurement of Salinity *continued*:**
  - Some typical values

"Common" Ranges

Electrical Conductivity, EC =

0.1 – 4.0 dS/m (mmho/cm)

Sodium Adsorption Ratio, SAR=

0.3 – 15

The Four Rules

- **RULE #1:** All waters used for irrigation contain salts (a) of some kind, and (b) in some varying amount
- **RULE #2:** Salinization of soil and water is inevitable to some extent
- **RULE #3:** An irrigated agroecosystem cannot be sustained without some drainage, either natural or artificial
- **RULE #4:** Rules 1 through 3 can't be changed

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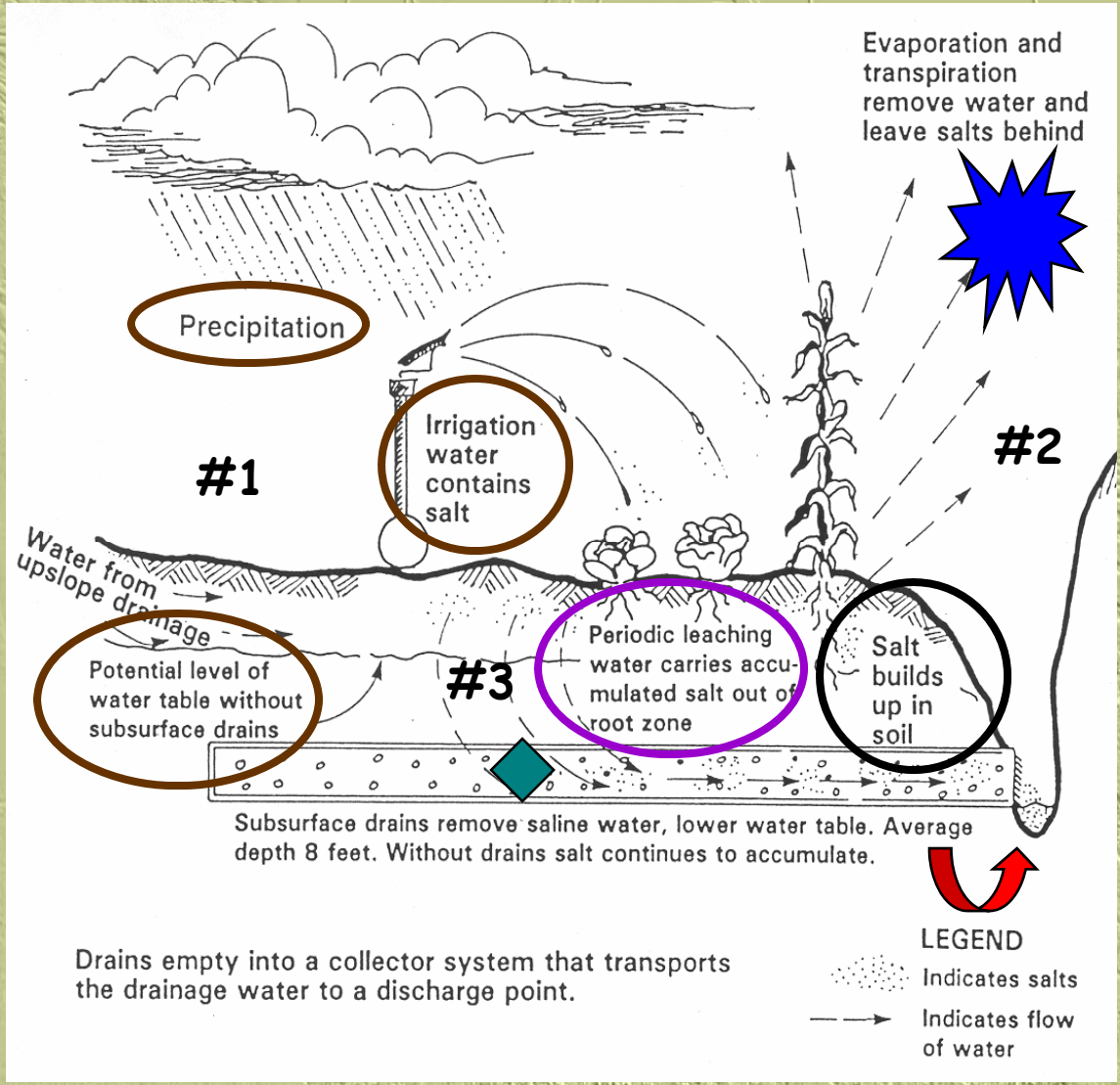
- Illustration of the "Four Rules"
- Mechanisms of Salt Accumulation in Irrigated Systems



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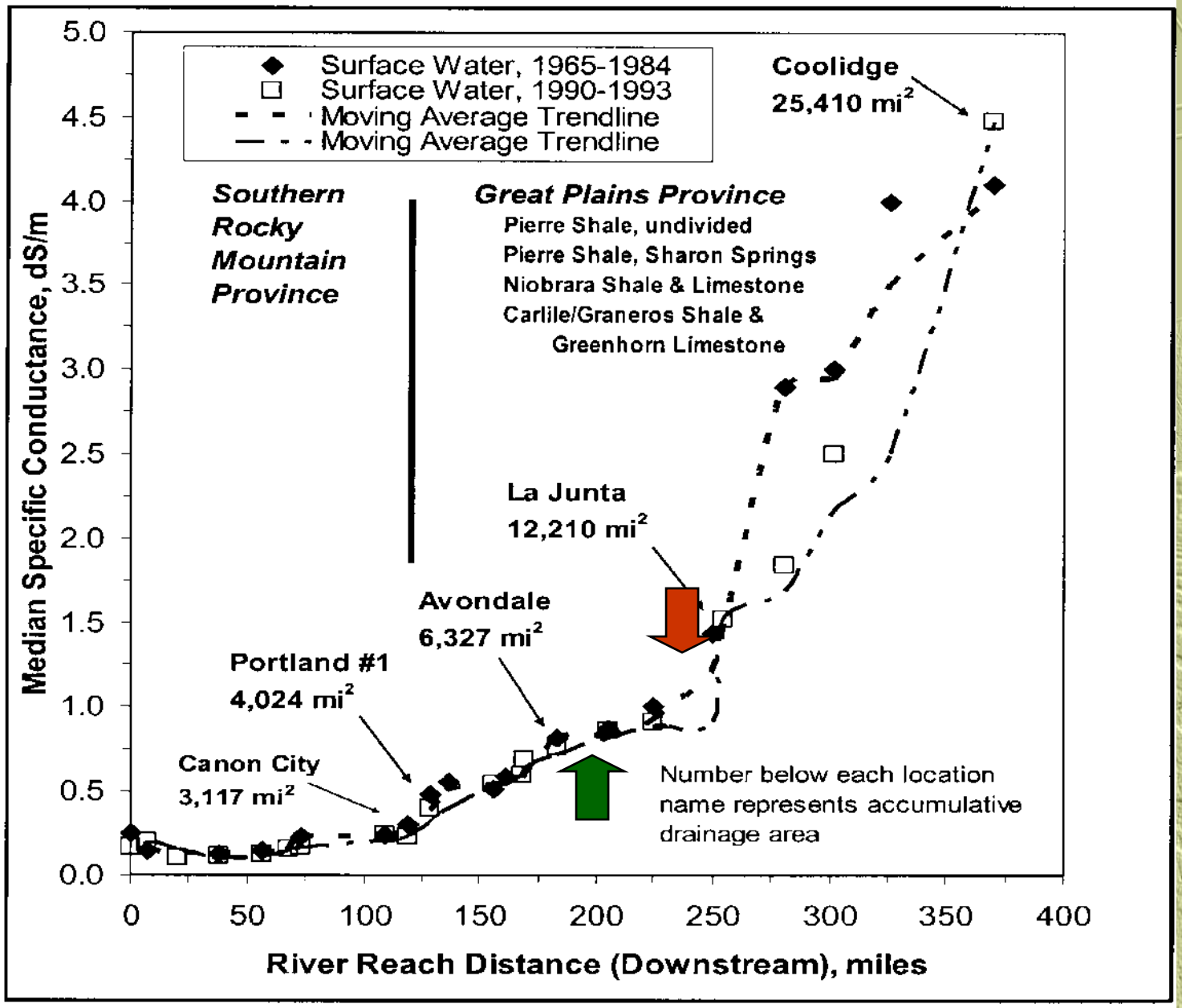

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Management Cornerstone #1

- The Selection of Management Options Starts with the Assessment of Irrigation Water Suitability

✓ Evaluation should be based on the water's potential for creating soil conditions hazardous to crop growth

- Inventory of the water's chemical composition

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Management Cornerstone #1

Water Source	Cations				Anions				EC_w	SAR	pH
	Ca	Na	Mg	K	Cl	SO_4	HCO_3	CO_3			
	meq/l								dS/m		
Canal	5.40	8.05	4.28	0.0	0.83	14.16	2.74	0.0	1.49	3.70	8.2
Well	21.48	29.39	21.58	0.0	2.48	62.46	7.51	0.0	5.35	6.76	8.0
Sump	17.18	25.32	18.94	0.0	3.33	49.97	8.14	0.0	4.50	6.49	8.1

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Management Cornerstone #2

- **Deliver Irrigation Water to Fields Efficiently**

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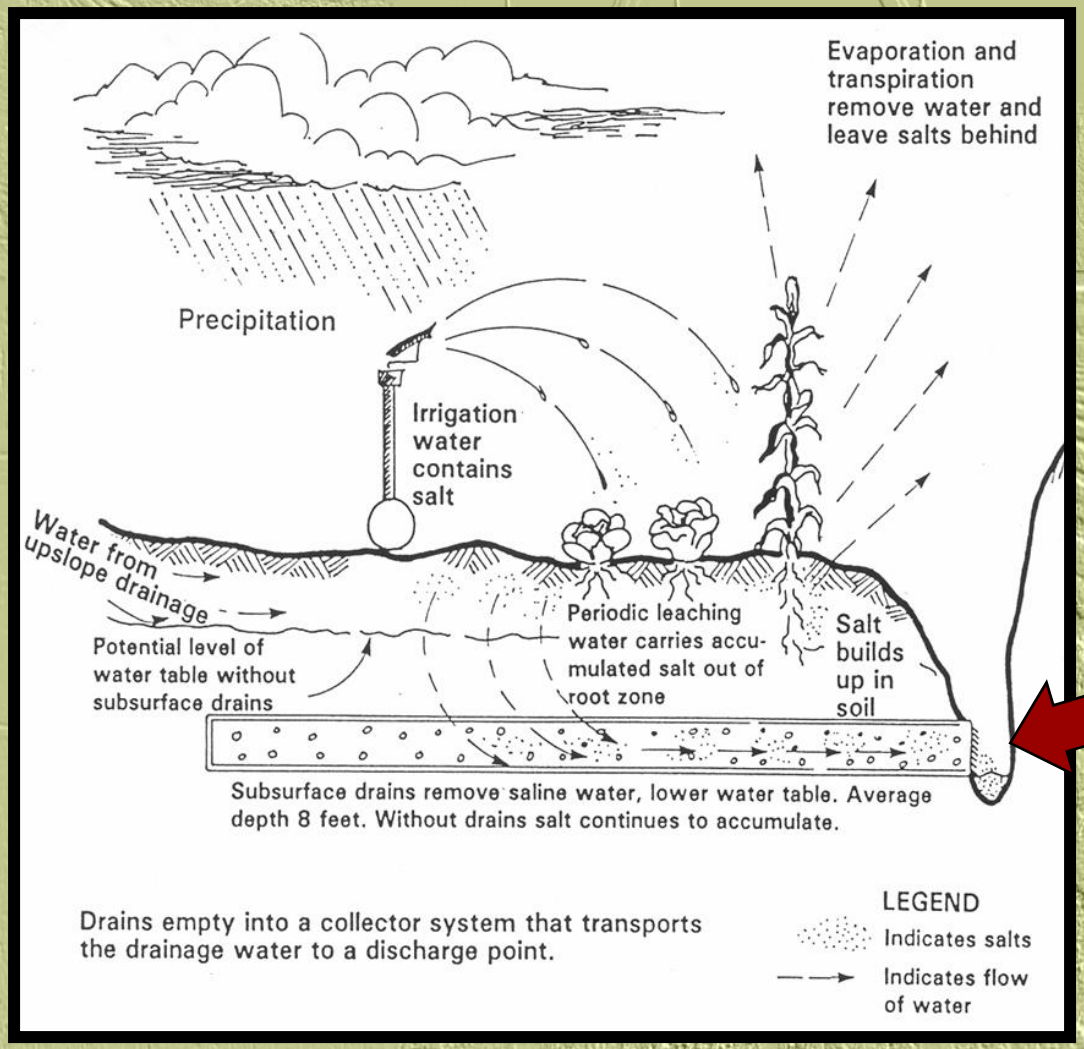
Management Cornerstone #3

- **Provide Adequate Drainage**

The total salt burden of drainage waters is LESS in waters exposed to the atmosphere than the waters percolating through the soil profile into the ground water.



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Management Cornerstone #3

- **Provide Adequate Drainage**
- **Drainage Districts**
  - SE Colorado Drainage Districts
    - ✓ By 1925, at least 30
  - Examples:
    - Wiley of Big Bend
    - Holbrook
    - Numa
    - A.B.S. Company
      - No.1
      - No. 2
      - East Farm

- **Fairmont Drainage District**
  - ✓ **Est July 13, 1917**
  - ✓ **1,900 acres within district boundary**
  - ✓ **909 acres within the drainage system**
  - ✓ **22 miles of drains**
  - ✓ **Total cost = $47,000**
    - **$22,000 Cash**
    - **$25,000 Bonds**

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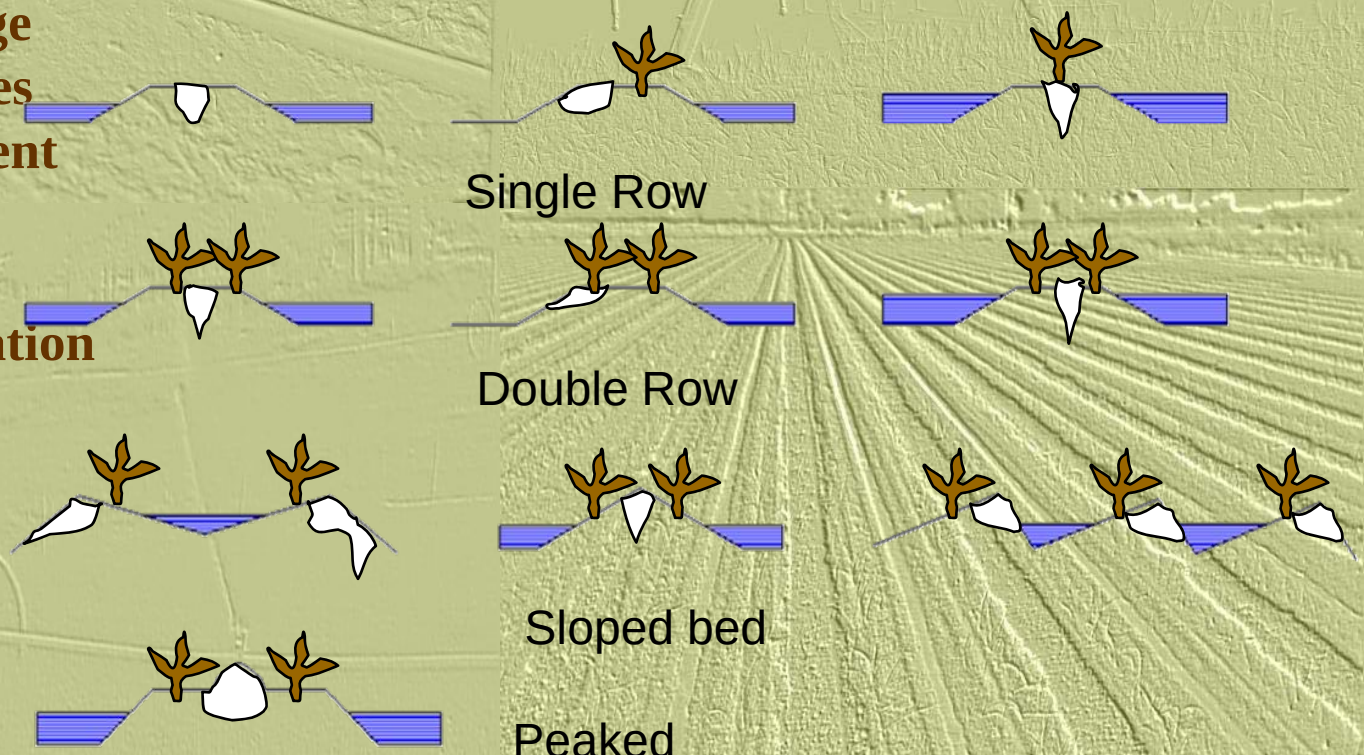
Management Cornerstone #4

- Use Planting and Tillage Procedures that Prevent Excessive Salinity Accumulation in the Seedbed



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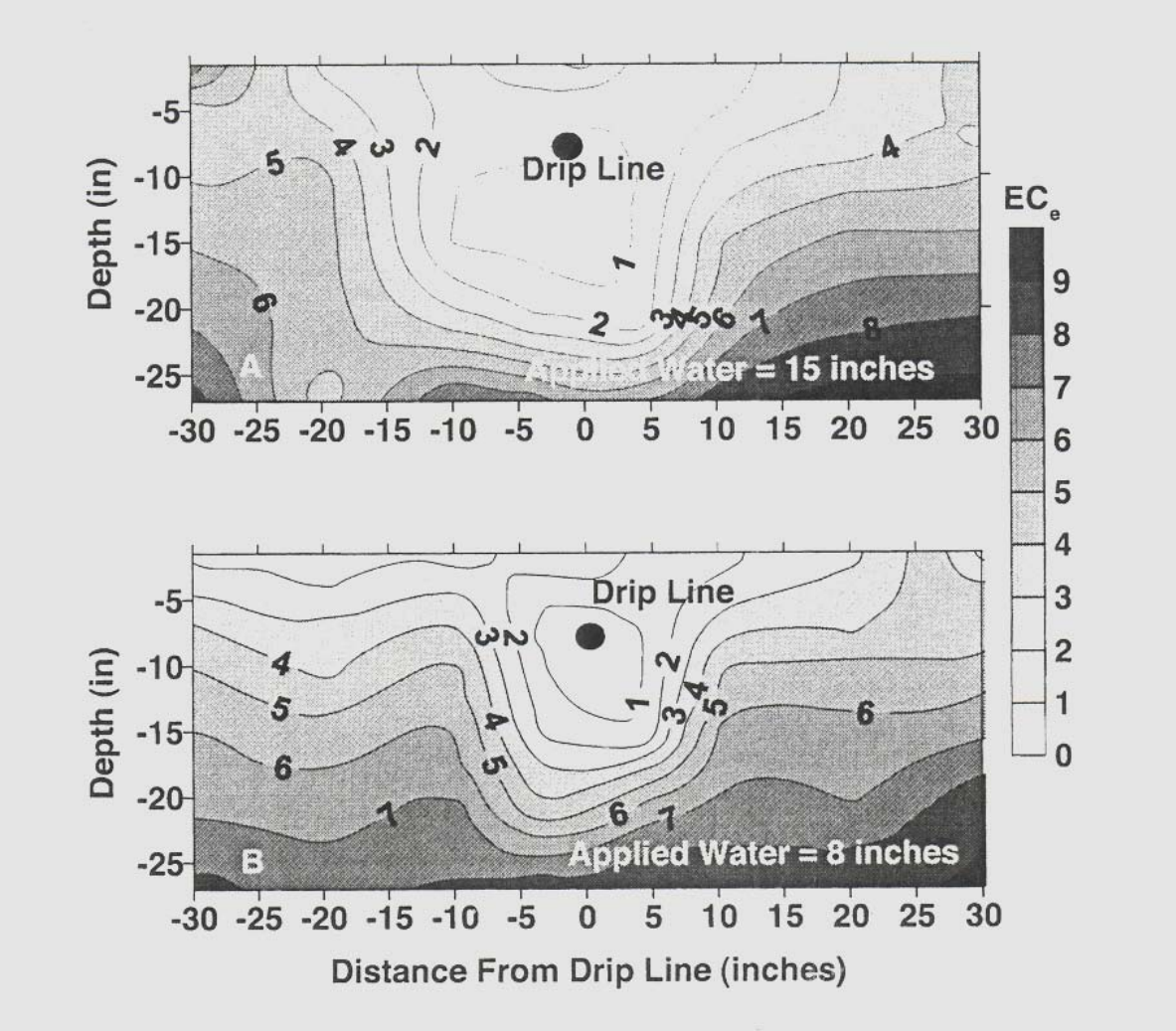

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Management Cornerstone #5

- Know Your Cropping and Soil Limitations and Grow Suitable Salt Tolerant Crops

✓ The adverse effects of salts are divided into three parts:

- Direct Effects on Plants
  - 1. Osmotic effect
  - 2. Specific ion effects
- Indirect Effect
  - 3. Soil dispersion due to excessive sodium

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Management Cornerstone #5 *continued*

- **Know Your Cropping and Soil Limitations and Grow Suitable Salt Tolerant Crops *continued***

Osmotic Effect

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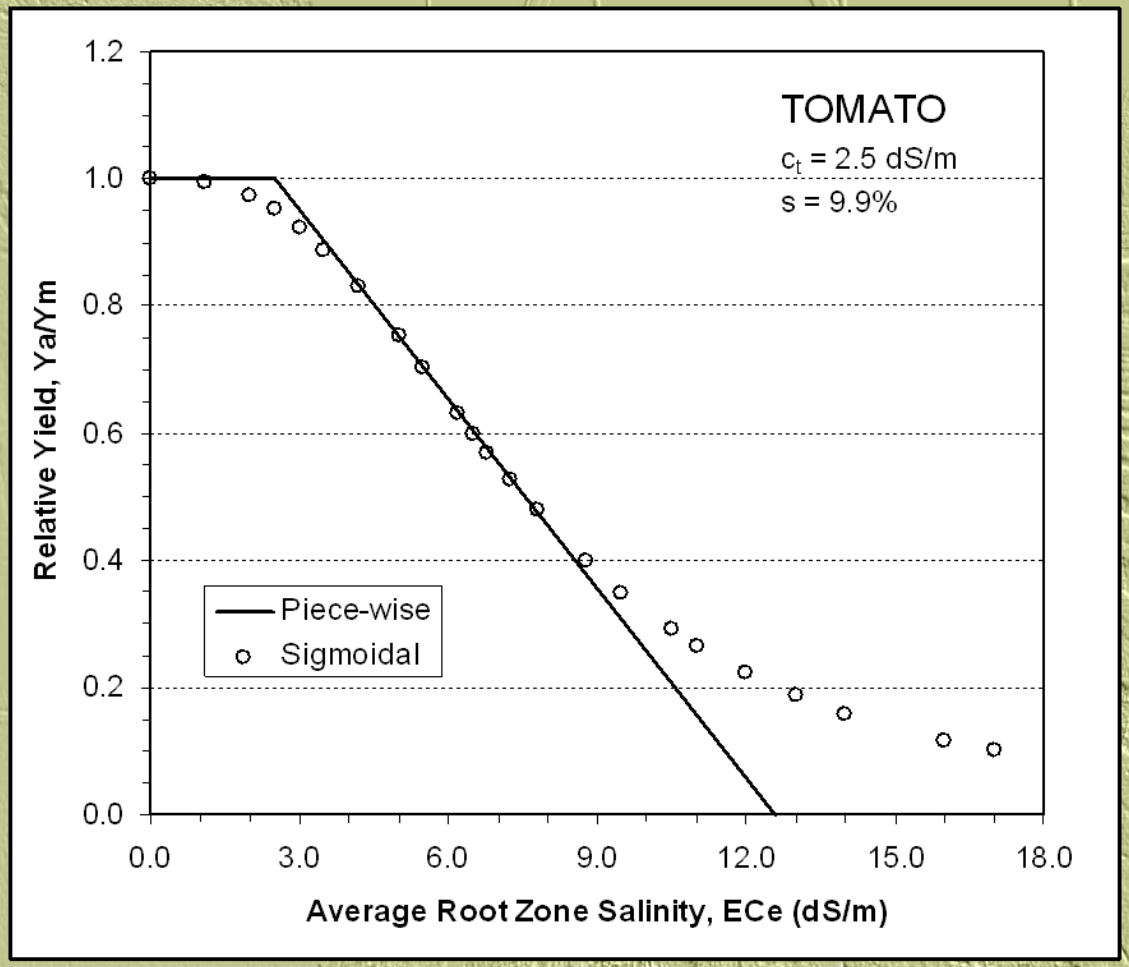
Management Cornerstone #5 *continued*

- **Know Your Cropping and Soil Limitations and Grow Suitable Salt Tolerant Crops** ***continued***



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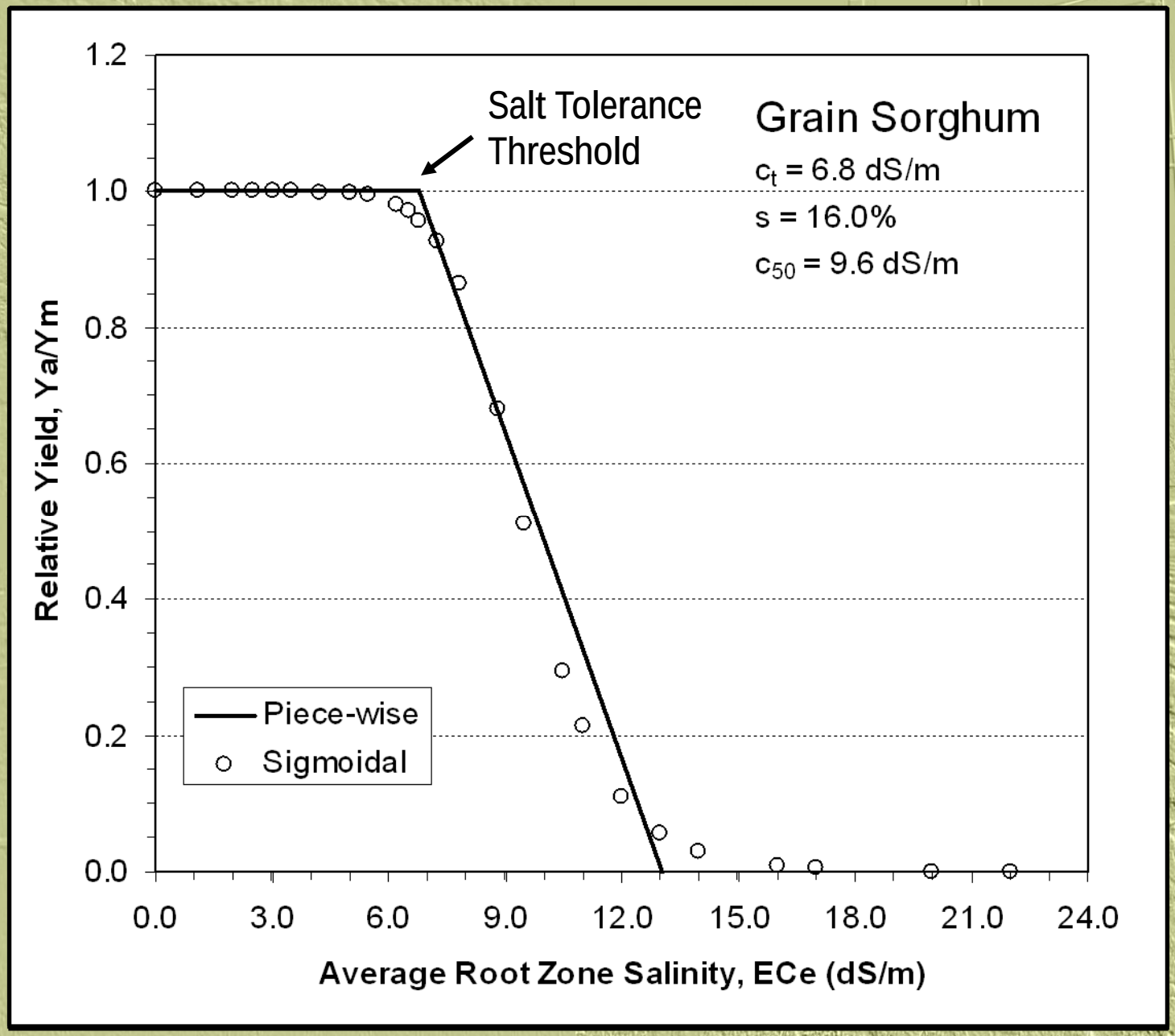

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Management Cornerstone #5 *continued*

Salinity Tolerance of Selected Produce Crops			
Crop	Treshold Value (dS/m)	Crop	Treshold Value (dS/m)
parsnip	0.8	pepper	1.5
turnip, root	0.9	potato	1.7
carrot	1.0	spinach	2.0
green bean	1.0	tomato	2.5
eggplant	1.1	garlic	3.9
onion	1.2	squash, summer	4.7
cantaloupe	1.3	artichoke, globe	6.1

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Management Cornerstone #5 *continued*

- **The sensitivity of crops to soil salinity often varies between stages of growth**
  - **Most plants are tolerant during germination**
  - **Plants become much more sensitive during emergence and seedling growth**
  - **Plants are generally more tolerant during the reproductive growth stages; some become dramatically more tolerant; and in some cases elevated salinity levels are beneficial during the later stages of growth**

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Management Cornerstone #5 continued

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Management Cornerstone #5 *continued*

- **Know Your Cropping and Soil Limitations and Grow Suitable Salt Tolerant Crops** ***continued***

Specific Ion Effects

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Management Cornerstone #5 *continued*

- **Know Your Cropping and Soil Limitations and Grow Suitable Salt Tolerant Crops** ***continued***

✓ **Response of Soils to Saline and Sodic Conditions**

- ❑ **Salinity and sodicity affects soil structure which in turn affects permeability and infiltration**
- ❑ **<u>Excess</u> sodium relative to the amount of calcium and magnesium, combined with low soil water EC is a bad thing!**

Infiltration Effects

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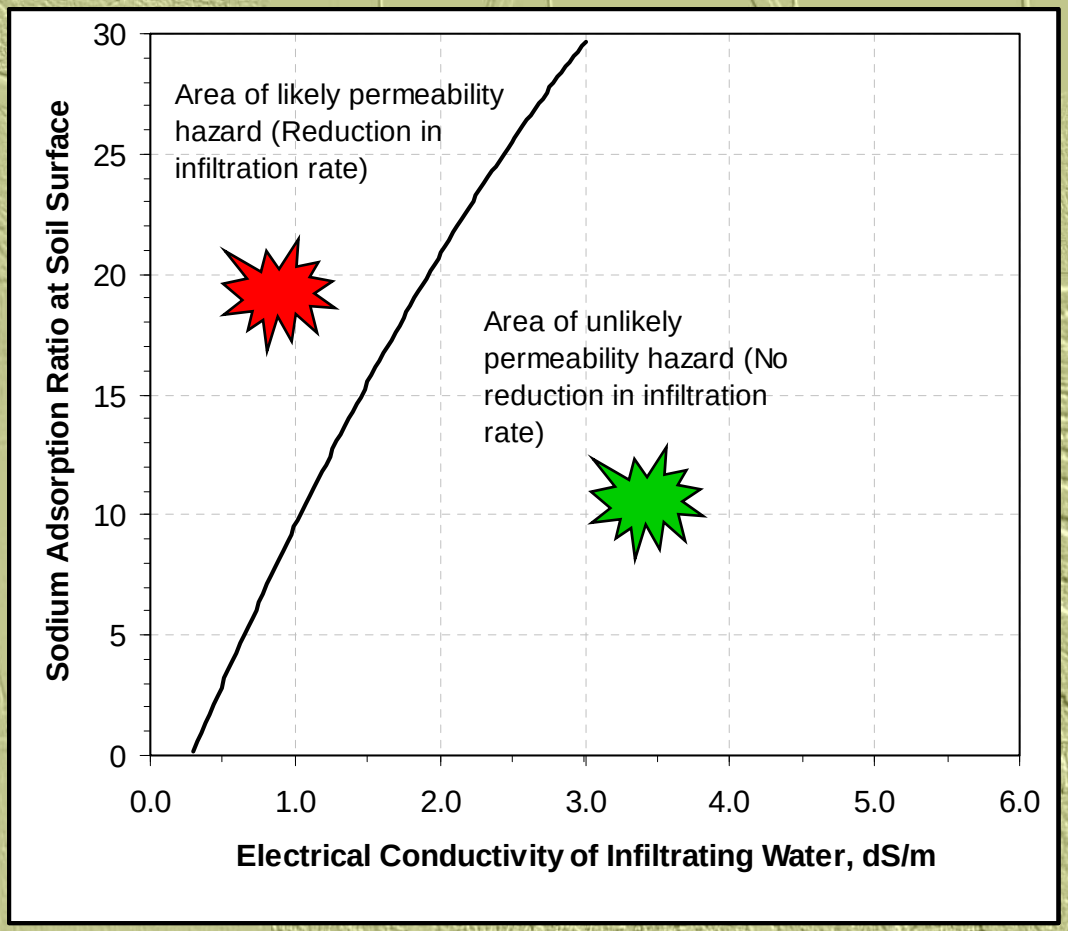
Management Cornerstone #5 *continued*

- **Know Your Cropping and Soil Limitations and Grow Suitable Salt Tolerant Crops *continued***

Infiltration Effects



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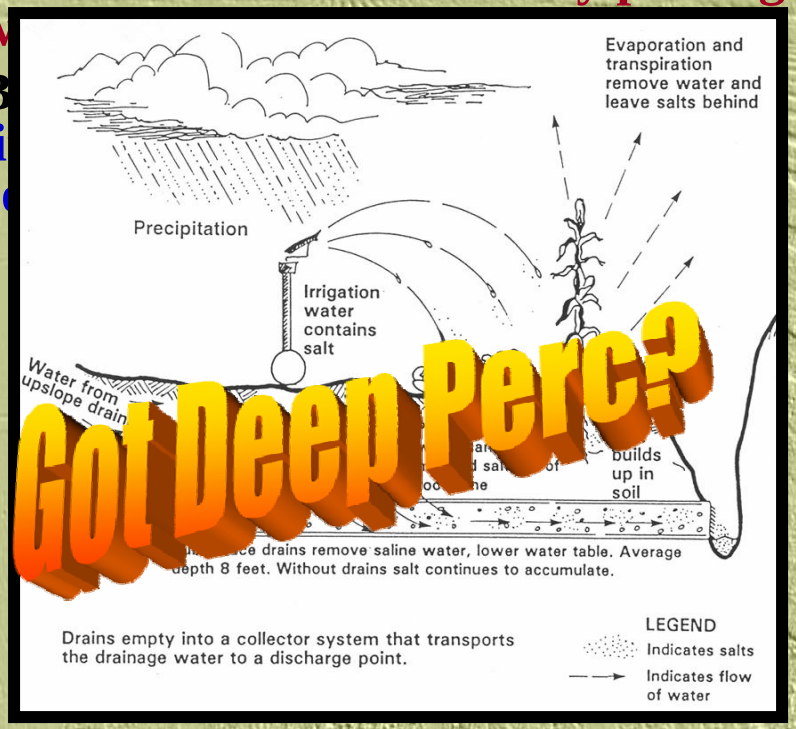
Management Cornerstone #6

- Apply Irrigation Water in an Efficient and Uniform Manner that Minimizes the Leaching Fraction
- Leaching Fraction- The portion of the infiltrated water volume that passes through the root zone and out the bottom

- ✓ Premise: it's okay to use the root zone as a salt sink……..to the extent that the use of the site specific soil resource is not compromised
- ✓ Goal: to move only a portion of the salts below the root zone by passing w
- ✓ B li r



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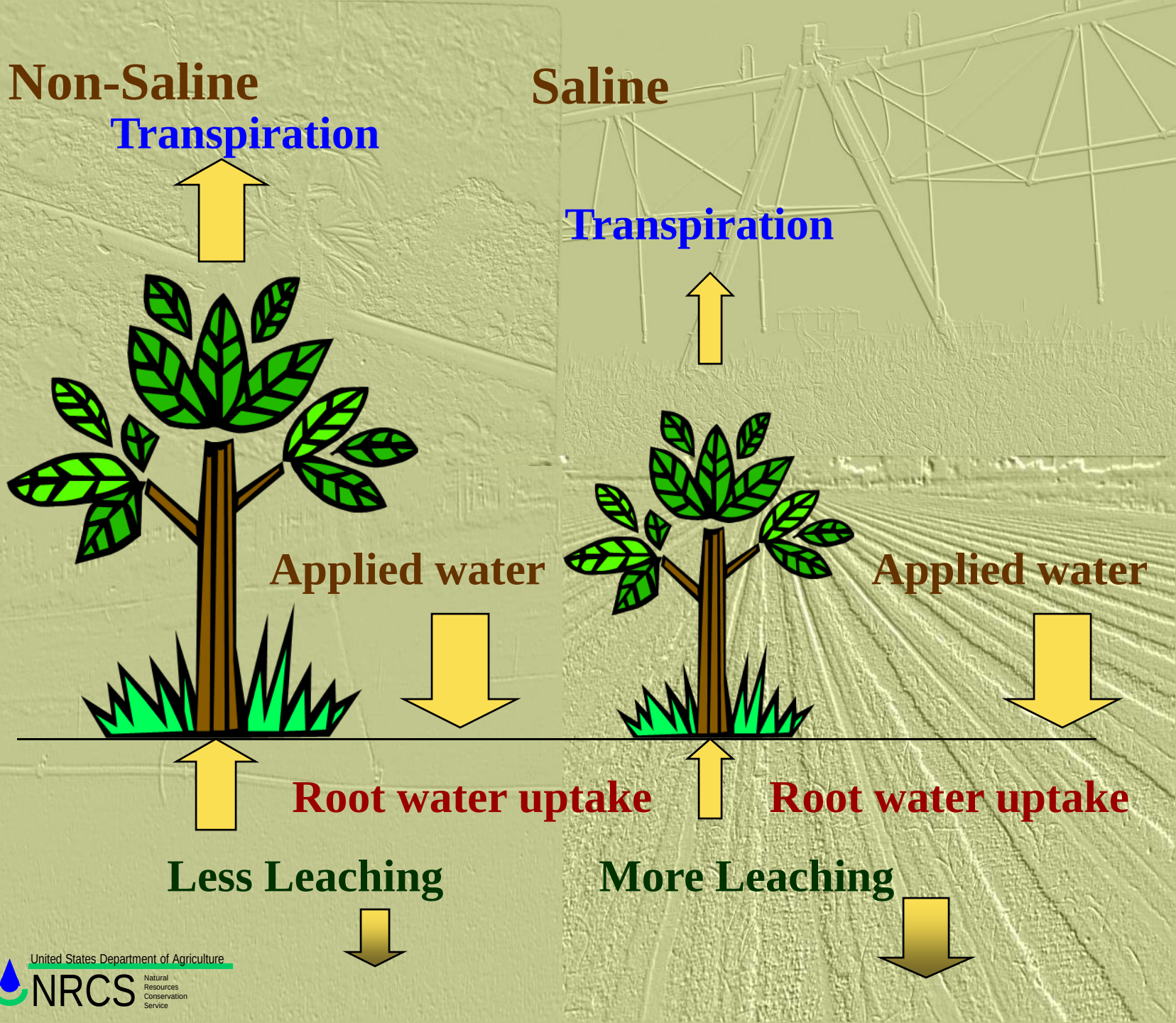

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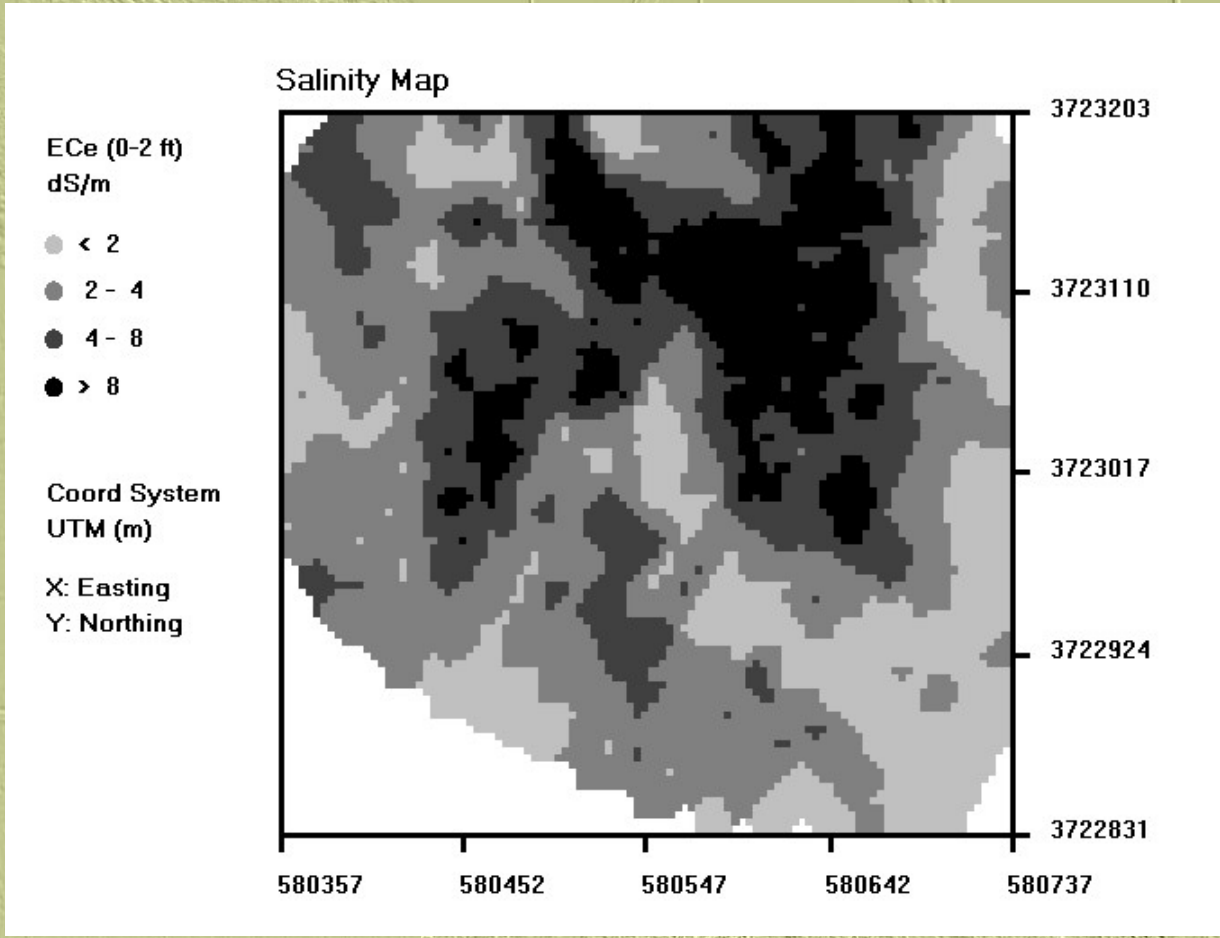
Management Cornerstone #7

- **Monitor Irrigation Adequacy and Soil Profile Salinity**



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Summary

- #1: Start with an assessment of irrigation water for its suitability
- #2: Deliver irrigation water to fields efficiently
- #3: Provide adequate drainage
- #4: Use planting and tillage procedures that prevent excessive salinity accumulation in the seedbed
- #5: Know your cropping and soil limitations and grow suitable salt tolerant crops
- #6: Apply irrigation water in an efficient and uniform manner that minimizes the leaching fraction (deep percolation)
- #7: Monitor irrigation adequacy and soil profile salinity