Dealing with sodic water & soil

Larry A. Stein

Texas A&M AgriLife Extension


Water is the key to finding gold in orchards and vineyards

Water

- Turgor pressure to expand cells
- All contain salt
- Key is how much?
- And what kind?

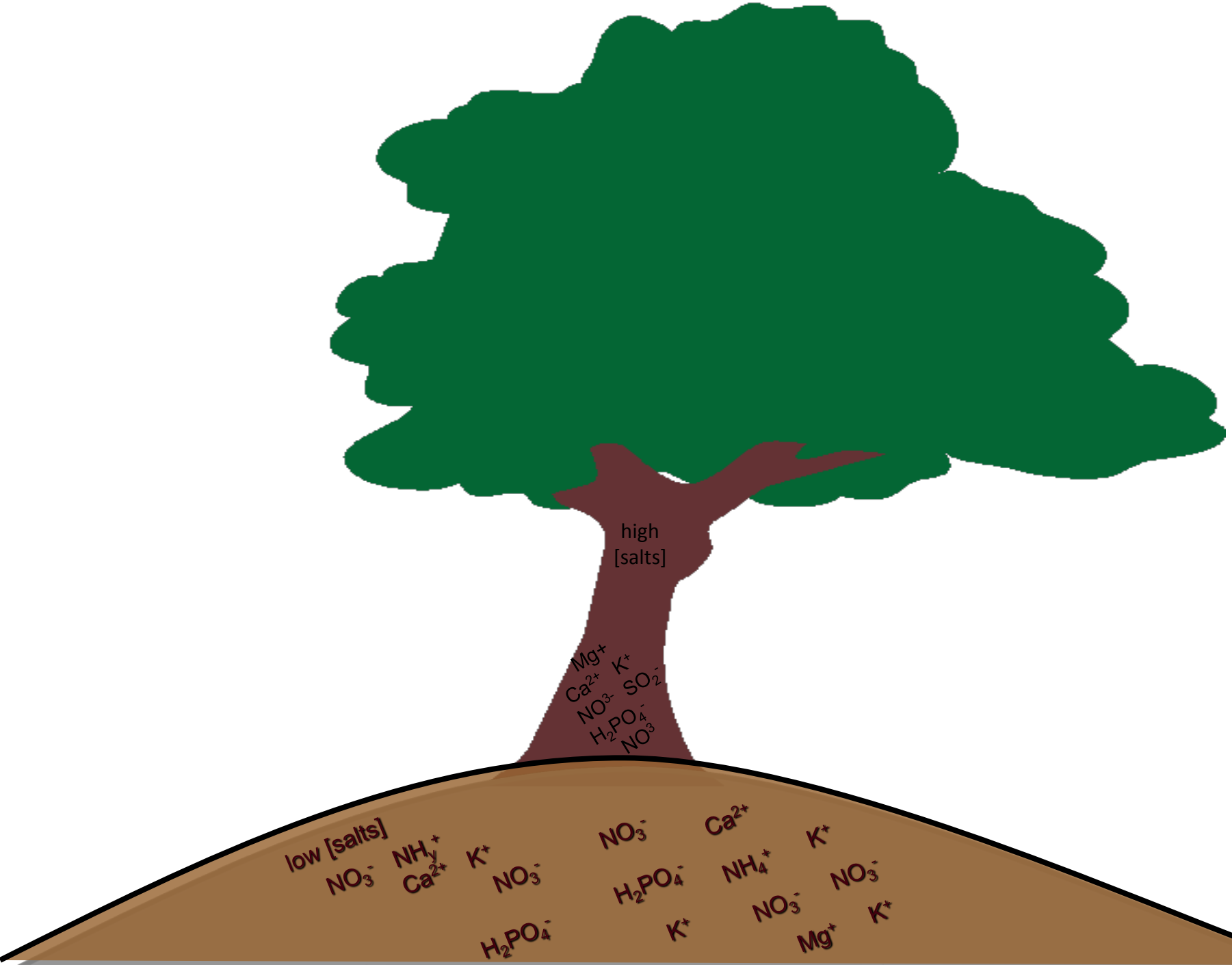
Water

Water moves from a high concentration to a low concentration

Said another way water moves to a higher concentration of salts

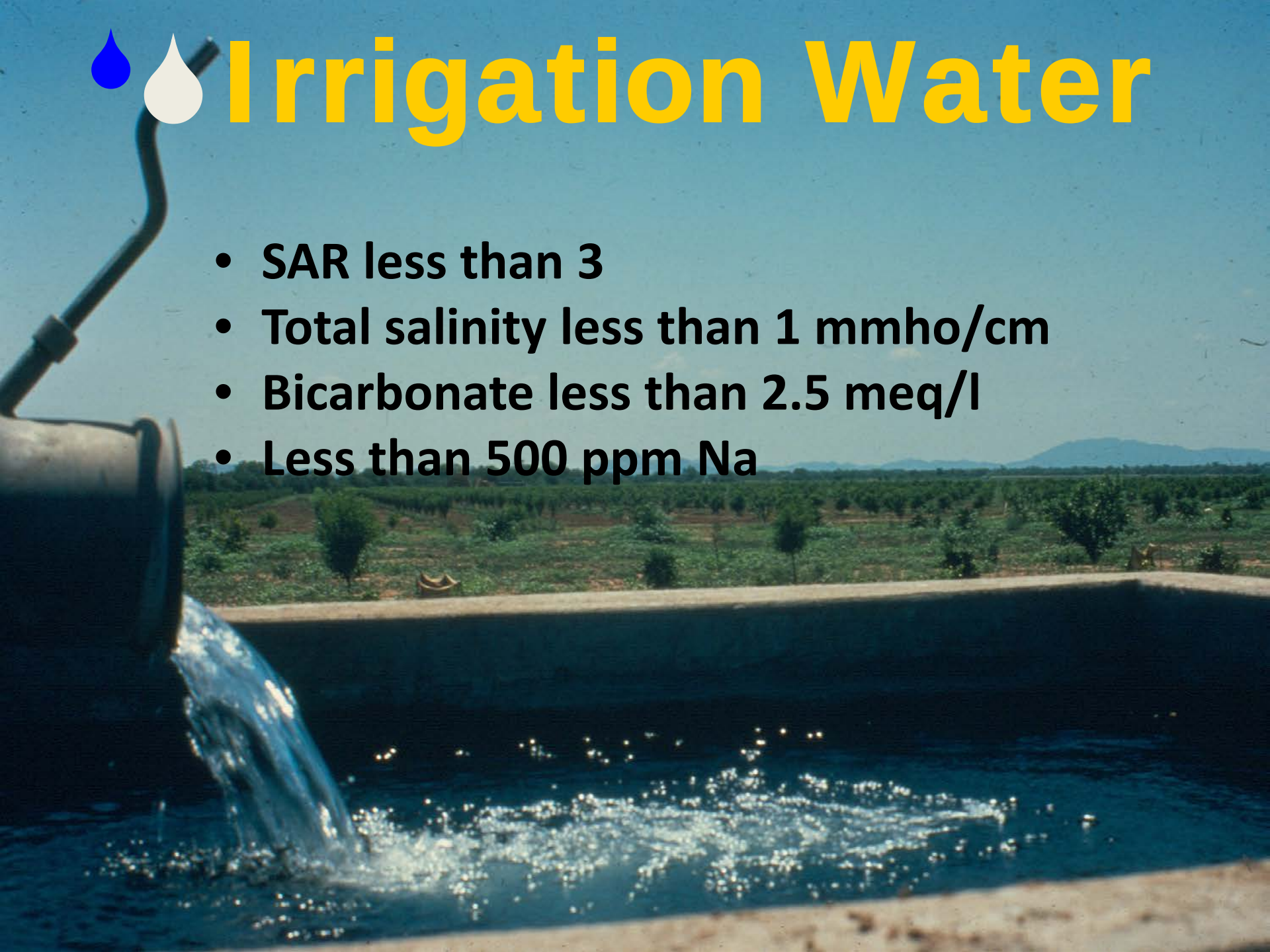
Salinity

- Describes dissolved solids in water and soil
- How much
- What kind
- Too much in soil solution; water moves out of the plant
- Less water available to plant


high
[salts]
Mg+
Ca^{2+}
K^+
NO_3^-
SO_2^-
$H_2PO_4^-$
NO_3^-
low [salts]
NO_3^-
NH_y^+
Ca^{2+}
K^+
NO_3^-
$H_2PO_4^-$
NO_3^-
Ca^{2+}
K^+
$H_2PO_4^-$
NH_4^+
NO_3^-
K^+
NO_3^-
Mg^+
K^+

Irrigation Water

- SAR less than 3
- Total salinity less than 1 mmho/cm
- Bicarbonate less than 2.5 meq/l
- Less than 500 ppm Na



Salt Affected Trees

- Stunted, lack vigor, small leaves
- Older leaves show marginal burn
- Leaf samples do not detect

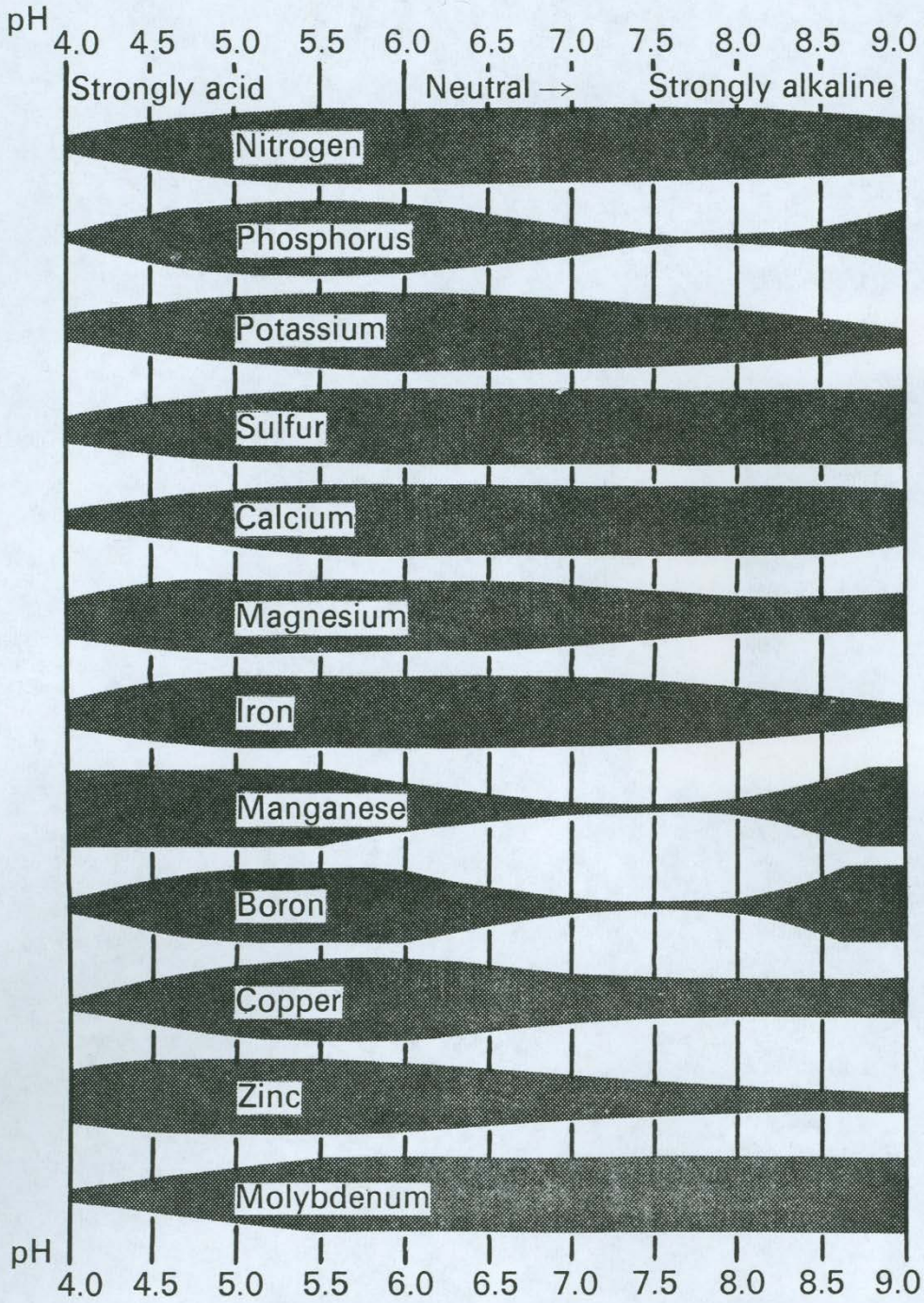
Sodic soil

- ESP greater than 15
- pH is typically between 8 and 10
- Loss of physical properties
- SAR is typically greater than 8

$$\mathrm{SAR} = \frac{Na^{+}}{\sqrt{\frac{1}{2}\left(Ca^{2+} + Mg^{2+}\right)}}$$

Plant growth affected by:

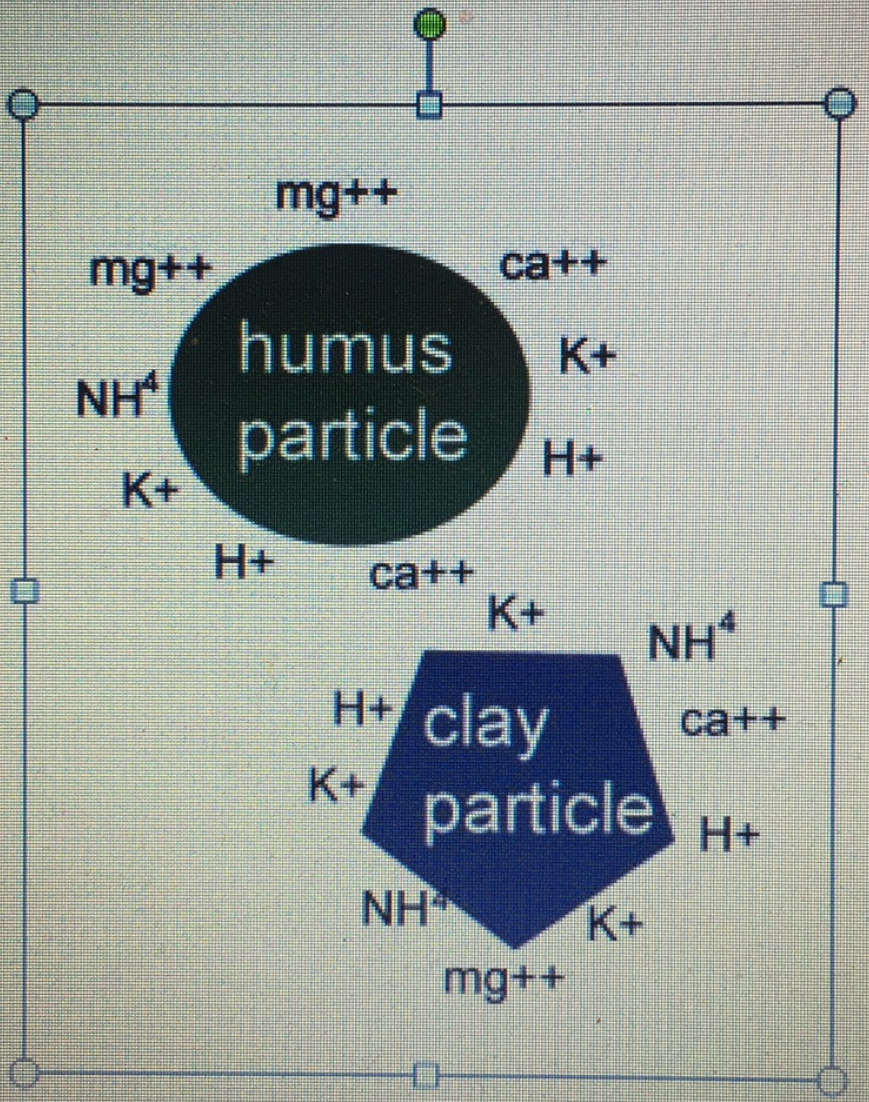
- Loss of soil permeability
- Effect on pH, increase thereby decreasing the availability of nutrients
- Toxic ions



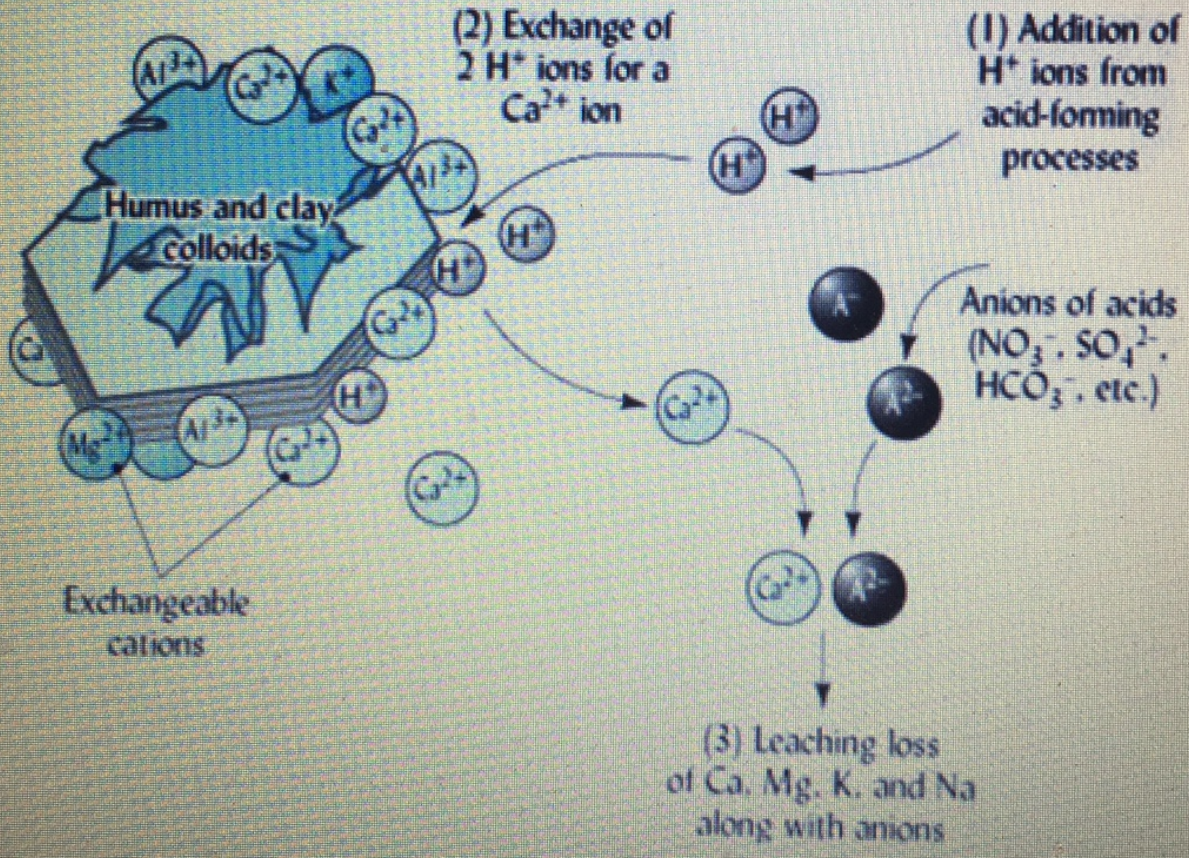
Influence of pH on the Availability of Nutrients

Reclamation

- Remove ESP
- Add amendments
- Leach
- Only works if soil drains


mg++
mg++
ca++
humus particle
K+
NH4
H+
K+
H+
ca++
K+
NH4
H+
clay particle
ca++
K+
H+
NH4
K+
mg++

Acid cations replacing non-acid cations on soil colloids



Amendments

- Soluble calcium ions; either gypsum or calcium chloride (very expensive)
- Acid; sulfuric or iron sulfate; forms sodium sulfate or sodium chloride
- Gypsum, incorporate
- Organic matter
- Mulching

Amendments

- For high sodium
- High bicarbonate
- Use gypsum

Gypsum

- **<u>Gypsum</u>** Gypsum is chemically $CaSO_4.2H_2O$ and is a white mineral that occurs extensively in natural deposits. It must be ground before it is applied to the soil.

- $Na_2CO_3 + CaSO_4$ Û $CaSO_3 + Na_2SO_4$ (leachable)

Calcium chloride

- **<u>Calcium chloride</u>** Calcium chloride is chemically $CaCl_2$ $2H_2O$. It is a highly soluble salt which supplies soluble calcium directly. Its reactions in sodic soil are similar to those of gypsum:

- $Na_2CO_3 + CaCl_2$ Û $CaCO_3 + 2$ NaCl (leachable)

Iron sulfate

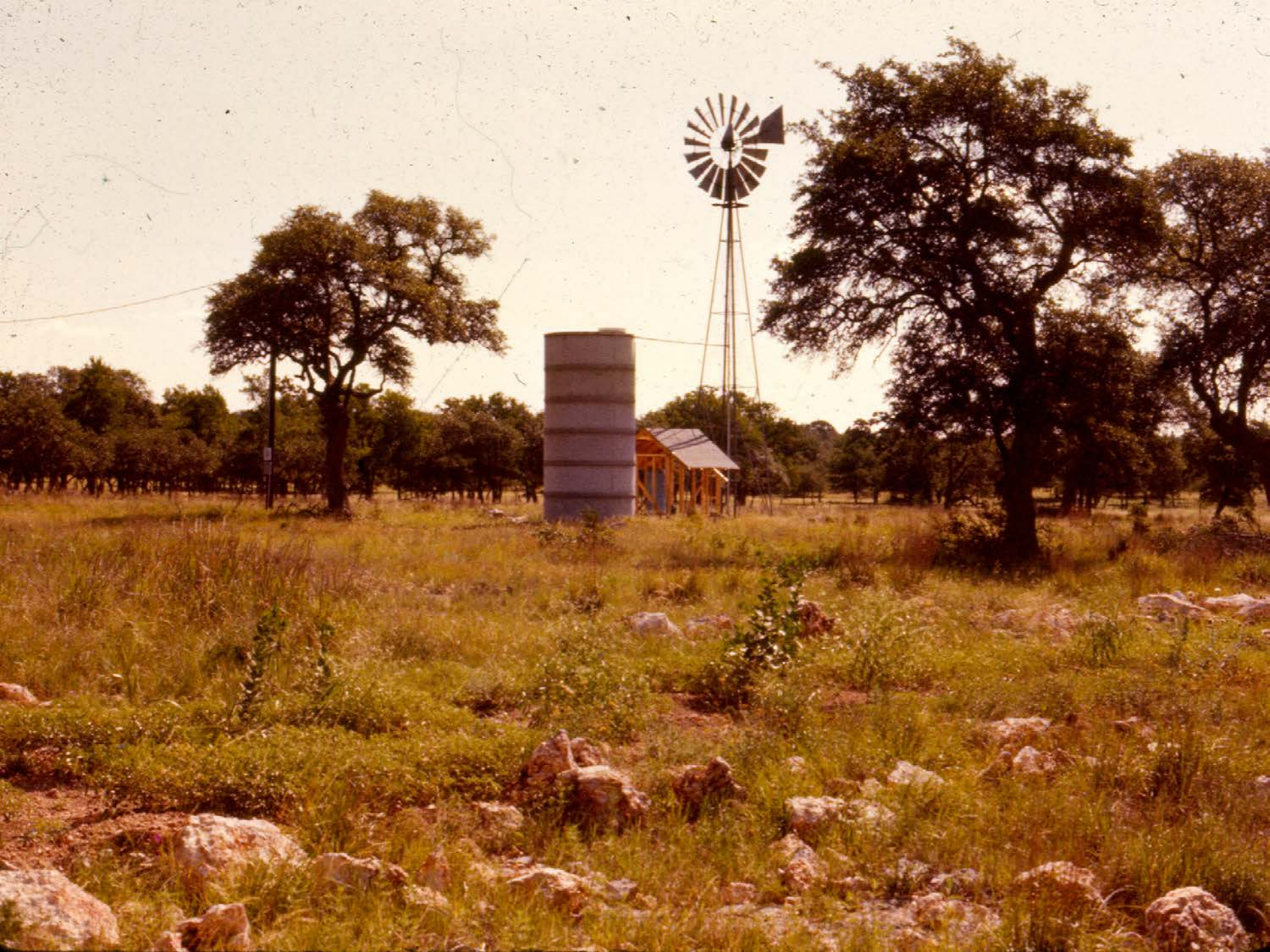
- **Iron sulfate** Chemically, $FeSO_4.7H_2O$
- When applied to soils, the iron sulfate dissolves in soil water and hydrolyse to form sulfuric acid, which in turn supplies soluble calcium through its reaction with lime present in sodic soils. Chemical reactions involved are:
- $FeSO_4 + 2H_2O$ Û $H_2SO_4 + Fe(OH)_2$
- $H_2SO_4 + CaCO_3$ Û $CaSO_4 + H_2O + CO_2$

Sulfuric Acid

- **<u>Sulfuric acid</u>** Sulfuric acid is chemically H_2SO_4. Upon application to soils containing calcium carbonate it immediately reacts to form calcium sulfate and thus provides soluble calcium indirectly. Chemical reactions involved are:
- $Na_2CO_3 + H_2SO_4$ Û $CO_2 + H_2O + Na_2SO_4$ (leachable)

Sulfur

- **<u>Sulfur (S)</u>** It is not soluble in water and does not supply calcium directly for replacement of adsorbed sodium. When applied for sodic soil reclamation, sulfur has to undergo oxidation to form sulfuric acid which in turn reacts with lime present in the soil to form soluble calcium in the form of calcium sulphate:
- $2\ S + 3\ O_2$ ® $2\ SO_3$ (microbiological oxidation)
  $SO_3 + H_2O = H_2SO_4$
- $H_2SO_4 + CaCO_3$ Û $CaSO_4 + H_2O + CO_2$



- Avoidance of problems areas is best control

Manure should be Avoided

- High salt content
- Tie up of iron and zinc

- Use High Quality in Tight Soil Areas
  - Periodic testing is a must

Reclamation efforts are often directed at improving soil drainage

- If the soil drains, there may not be a salinity problem

Drastic measures may be required

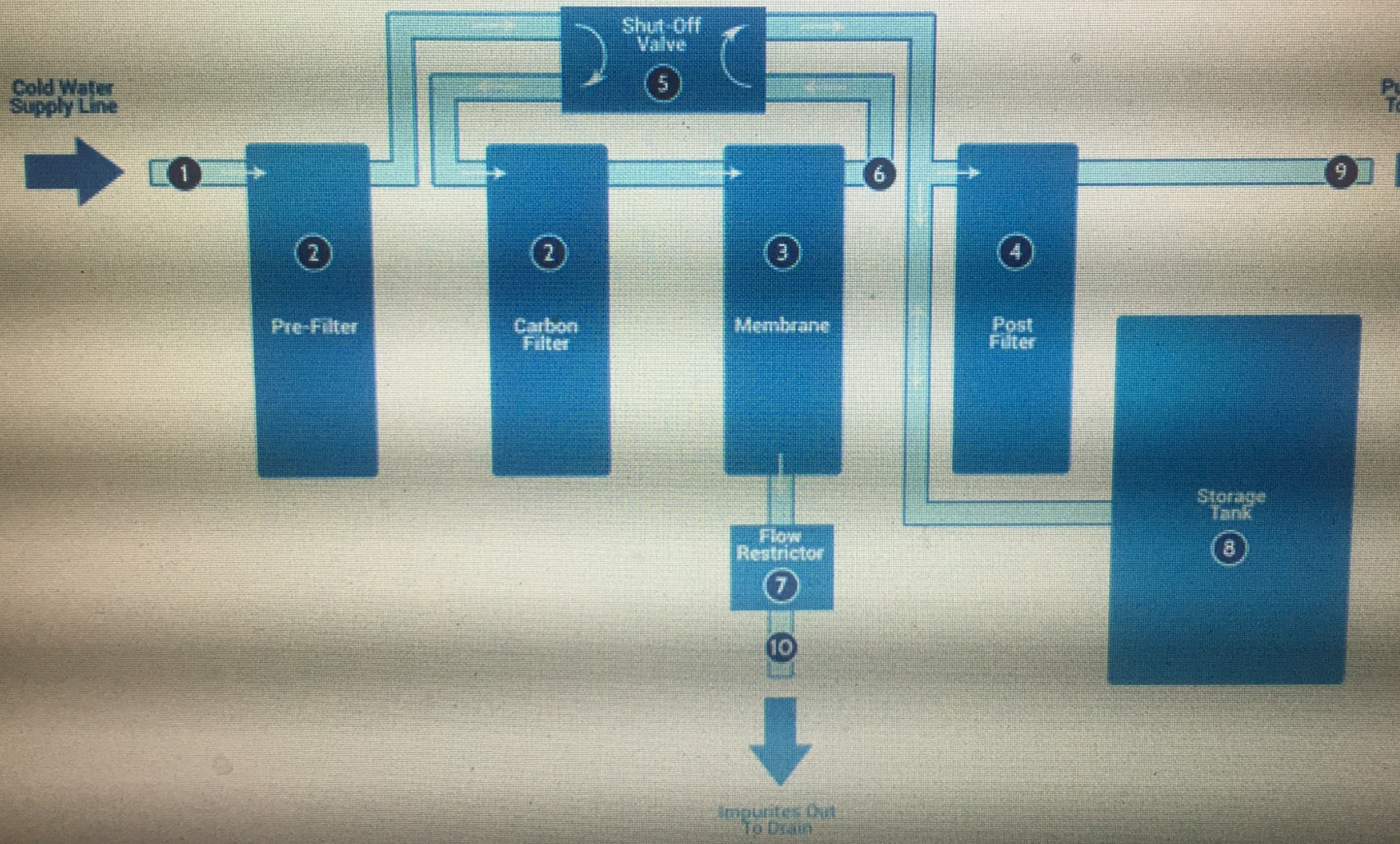
- Dig out clay lens and mix with another soil to improve drainage

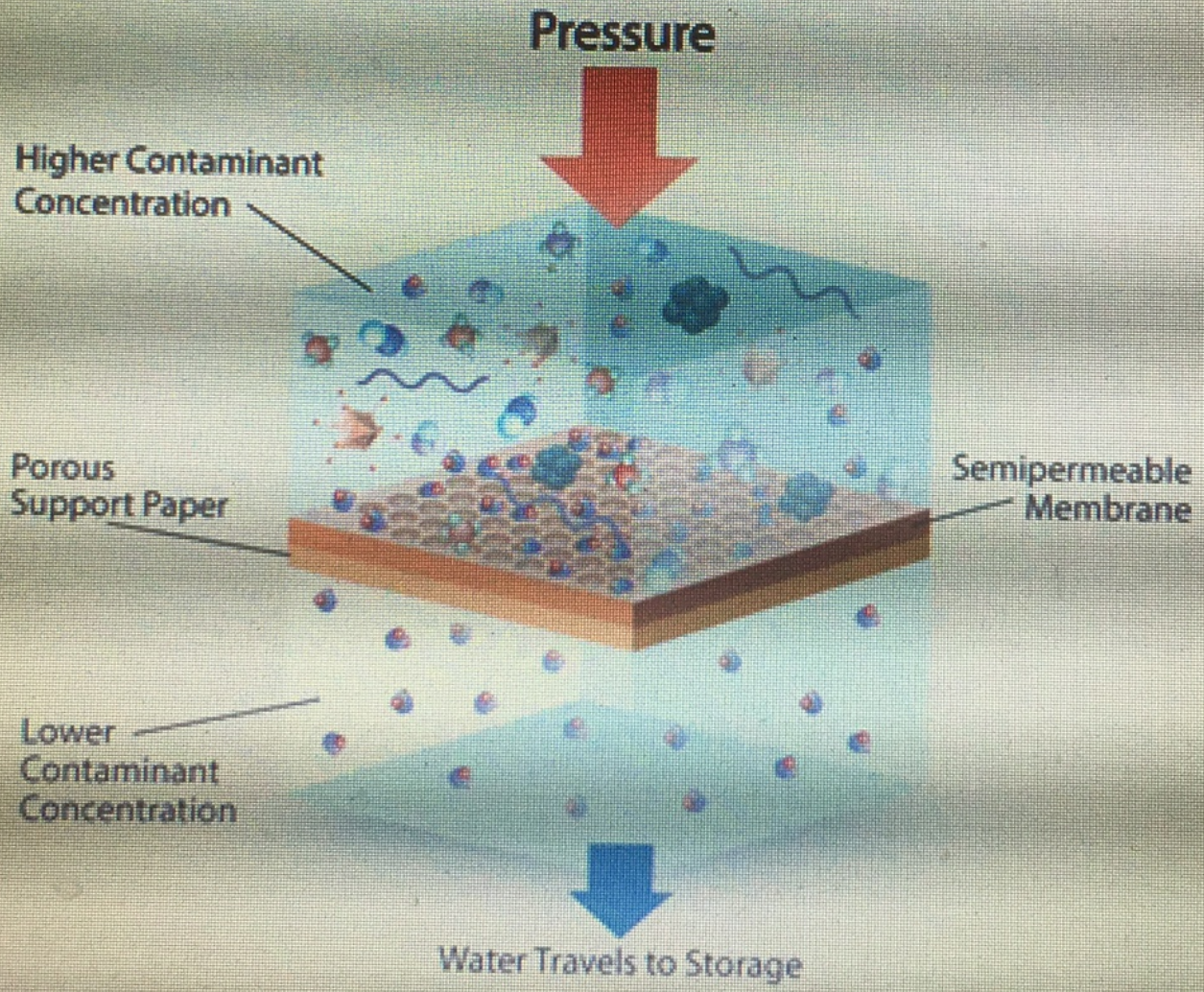
Deep chiseling or plowing can improve drainage


May have to install a drainage ditch or tile to remove excess water and salt

Reclamation

- Cannot add anything to water to clean; can only dilute salty water
- Alter chemistry of sodic water by adding calcium and magnesium
- However, you create saltier water
- Increasing SAR is a challenge with increasing water salinity


Cold Water
Supply Line
Shut-Off
Valve
5
1
2
Pre-Filter
2
Carbon
Filter
3
Membrane
6
4
Post
Filter
9
Storage
Tank
8
Flow
Restrictor
7
10
Impurities Out
To Drain


Pressure
Higher Contaminant Concentration
Porous Support Paper
Semipermeable Membrane
Lower Contaminant Concentration
Water Travels to Storage

Summary

- Soil and water tests to know your levels
- Soil drainage is the key
- Amendments; release calcium which replaces the sodium and then leach
- Avoid problem areas
- Cannot add something to water to clean
- Reverse osmosis