

Salinity and Sodicity Problems

- Prevention – select appropriate crops, maintain infiltration, take rainfall/snowmelt into account, control salinity and sodicity buildup through irrigation and rainfall.
- Correction (reclamation)
 - Prevent through good management
 - Requires water, sometimes also amendment,
 - cropping helps.

Crop and Soil

- The salinity of the irrigation water can limit crop selection.
- Leaching, a necessity for salinity/sodicity control, requires infiltration of more water, including rainfall, than the crop uses.

Rainfall impacts--a two edged sword

1. Reduces soil salinity and benefits crops growth.
2. Impairs, or harms, the hydraulic and physical properties of soils irrigated with saline-sodic water.



Crop salt tolerance

- Average rootzone salinity – time and depth averaged.
- Threshold salinity, EC_t
- Slope, % decline per unit increase in average rootzone salinity.

Corn: ECt and slope

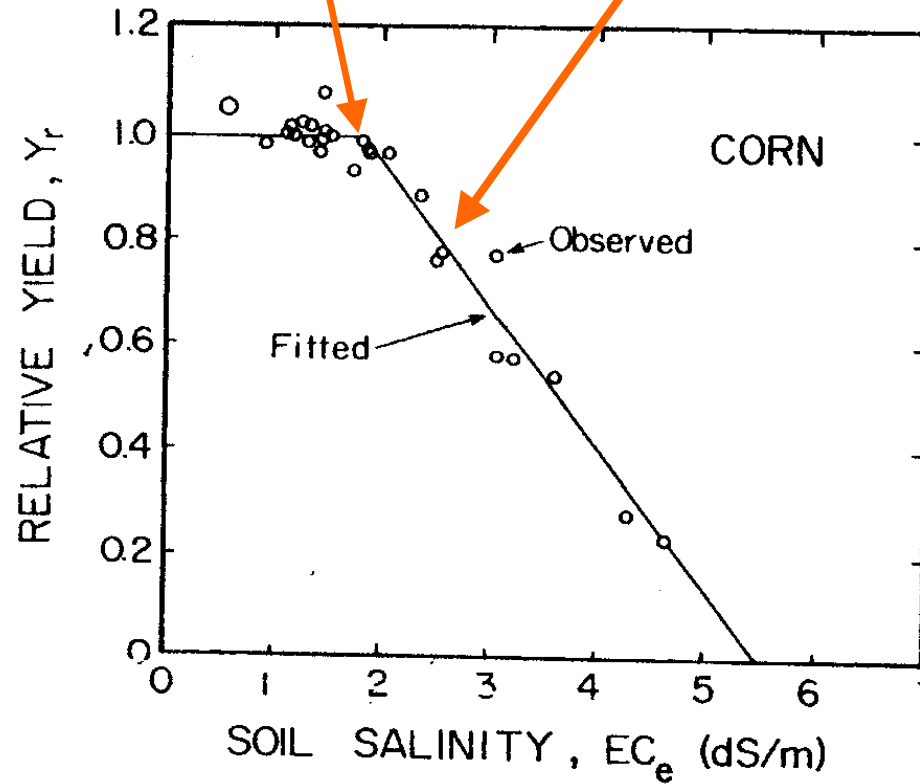


Fig. 3-2. The piecewise linear response function fitted to actual yield data obtained from corn [data from Hoffman et al. (1983)].

PAC CHOI

LATE

3

7

11

15

19

23

EC_{ms} (dS/m)



Leaching is achieved by applying more water, including rainfall and snowmelt, than the crop uses (evapotranspires).

Leaching controls salinity and sodicity (SAR/ESP).

How does one estimate the
Water Required to meet the
needs for both the crop and
for leaching?

$$\overline{EC_e} = \text{Conc. Factor } (f(LF)) * EC_{iw}$$

- Concentration factor times EC of irrigation water
- Provides an estimate of
- Average rootzone salinity
 - Concentration factor increases with decreasing leaching fraction.

Alfalfa (ECt of 2 dS/m)
ECiw greater than 2 dS/m?

LF	Conc. F	Av. Root Zone ECe	WR (% of ET)
0.3	1.0	2.0	140
0.1	2.1	4.1 (15% loss)	110

Wheat (ECt of 6 dS/m)
ECiw greater than 6 dS/m?

LF	Conc F	Ave Rootzone ECe	WR (% of ET)
0.3	1.0	6.0	140
0.1	2.1	13.0 (18% loss)	110

What happens if irrigation is not sufficient?

- Maximum yields will not be obtained.
- Leaching will still occur.
- Soil salinity and sodicity will increase.

Alfalfa ($EC_t = 2 \text{ dS/m}$)

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235

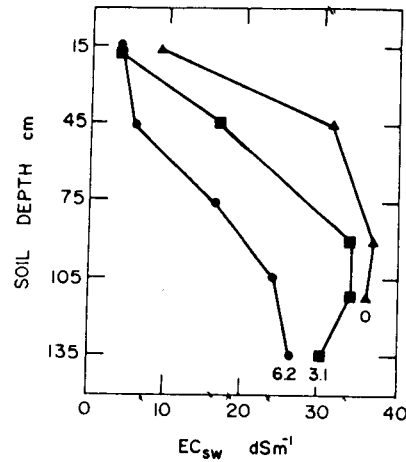


Fig. 1. Effect of reducing leaching fraction (LF) below salt balance limits for water of $2 \text{ dS} \cdot \text{m}^{-1}$, on the buildup of salinity in the root zone. Figures below curves indicate the LF (Van Schilfgarde et al., 1974).

Production function -- Alfalfa

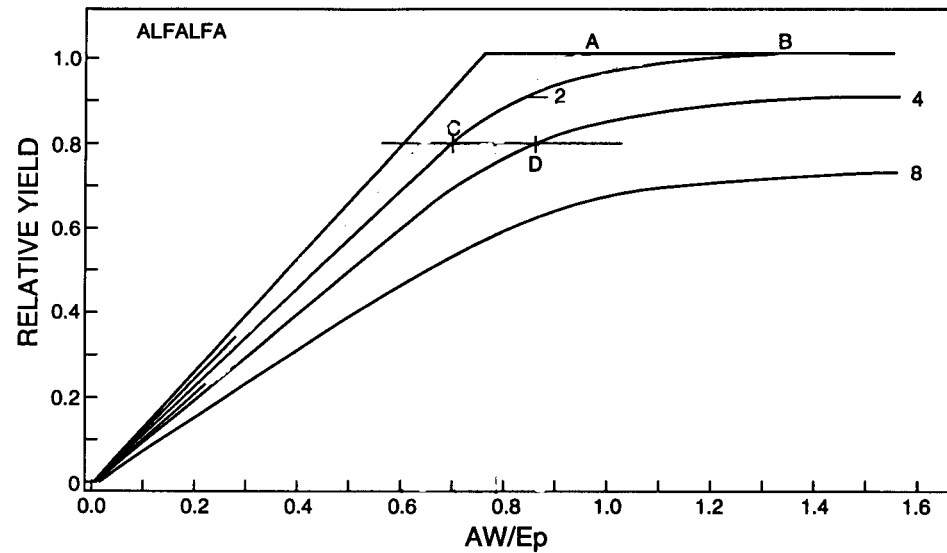
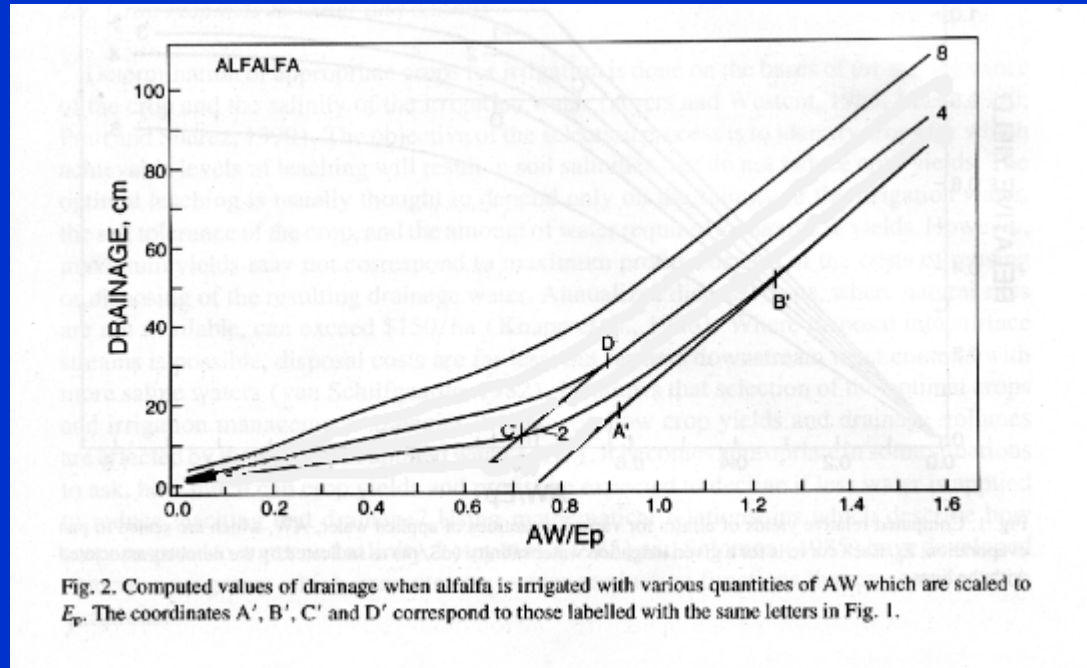


Fig. 1. Computed relative yields of alfalfa for various quantities of applied water, AW, which are scaled to pan evaporation, E_p . Each curve is for a given irrigation water salinity (dS/m) as indicated by the numbers associated with the lines.

Drainage function



What if the water table is too shallow? Leaching limited?

- Artificial drainage costs > \$600/ac.
- Disposal site for drainage water is needed.
- Environmental constraints? Discharge permits required?

Don't overirrigate – minimize leaching

Grow crops which are more salt tolerant.

Grow crops which can tolerate anoxic conditions.

Reclamation

- Whether soil salinity or sodicity, **always requires water and leaching** –
- Creates drainage water which requires **disposal** – rivers, lakes, vadose zone, groundwater

Reclamation of saline problem

- Sprinkling or intermittent ponding.
- Continuous flooding.

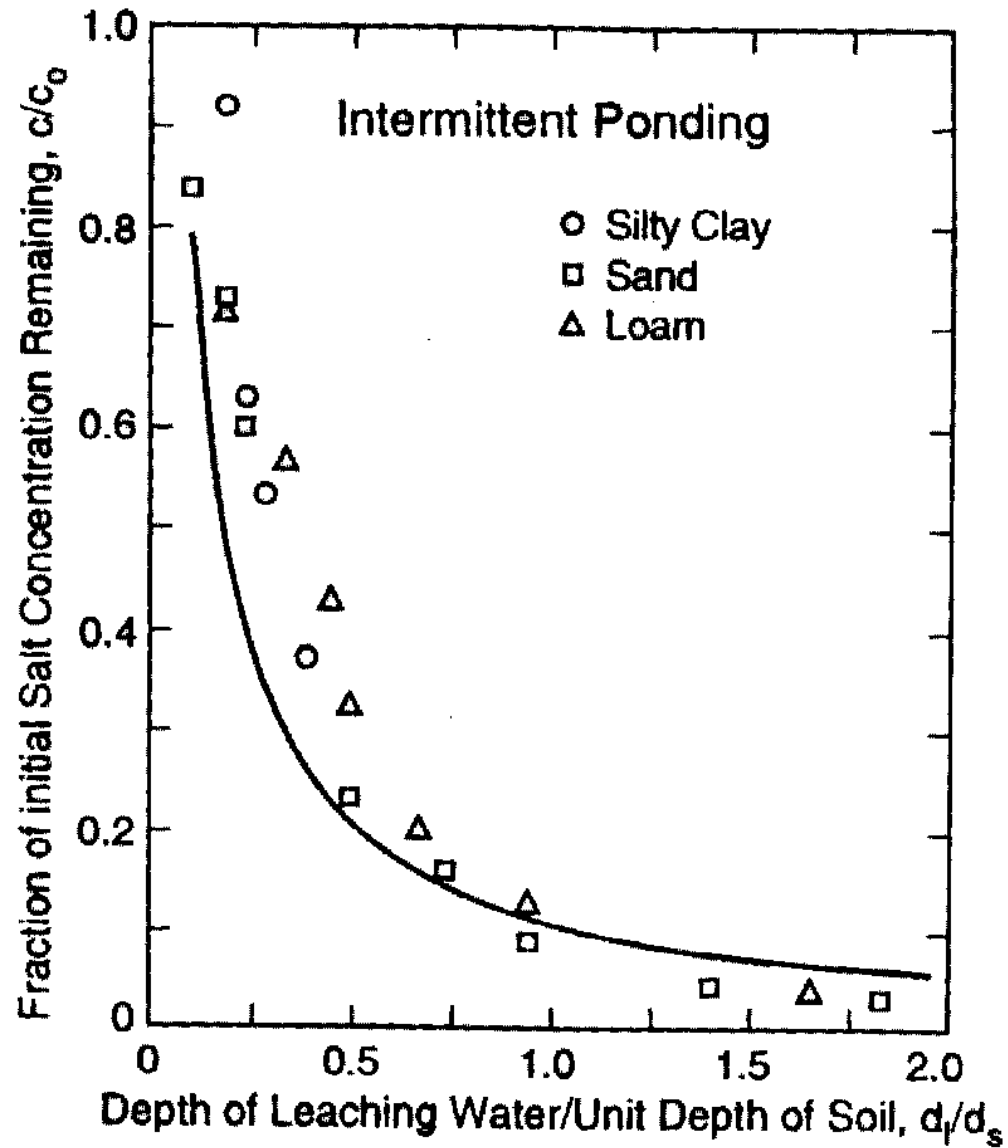


Fig. 19-5. Depth of leaching water per unit depth of soil required to reclaim a saline soil by ponding water intermittently (Hoffman, 1986).

Intermittent ponding or sprinkler

Independent of soil texture.

Guidelines:

4 inches of infiltrated water will leach about 90 % of the salt from the upper 4 inches of soil;

8 inches of water will do the same for the upper 8 inches of soil, and so forth.

Costs: Water and normal irrigation costs

Reclamation of sodic (SAR/ESP) problems is more expensive

- \$\$ for Amendments
- \$ for Application
- \$ for Water
- \$\$\$ for Drainage systems

Gypsum prescribed for

- Temporary improvement of infiltration rates
 - low salinity irrigation waters and rainfall
- Soil tilth: improvement and stabilization
- Soil reclamation

Infiltration rates are particularly sensitive to salinity and SAR

At the soil surface both are closely linked to the SAR and salinity of the irrigation water.

Rainfall also reduces salinity at the soil surface

1. An inch of rain can reduce soil salinity by 80 to 90 percent at the soil surface to a depth of one inch.
2. At the same time the reduction in SAR will be much smaller.

Ayers and Westcot adaptation of the Quirk/Schofield Stability Diagram: Effect of rain

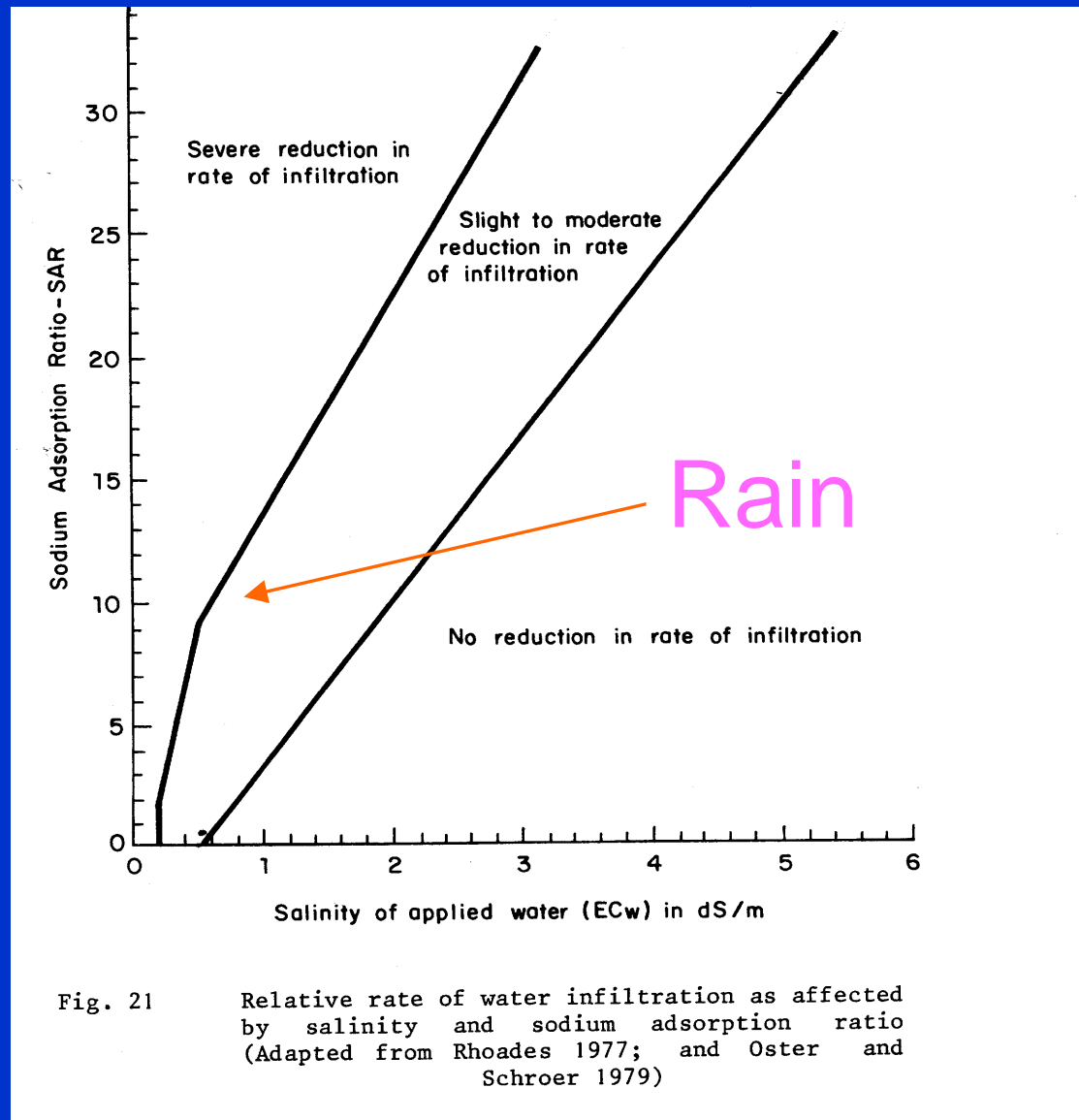


Fig. 21 Relative rate of water infiltration as affected by salinity and sodium adsorption ratio (Adapted from Rhoades 1977; and Oster and Schroer 1979)

Gypsum

Typical topical application rate: 2 to 3 tons/acre to improve infiltration and soil tilth

Gypsum costs in California

92 – 97 %

regular grind: \$41.00 per ton

fine grind: “solution grade”

\$75 to \$85 per ton

Long hauls (> 70 – 100 miles) to field

will increase the cost

Gypsum

Application costs: \$5 – 10 per ton

Depends on amount to be applied –
increases with application rate

GPS technology increases the cost.

Water run gypsum – Ca Farmer

Improves infiltration of a loam to clay loam soil.

About \$40.00/acre-yr

- Applies 0.5 ton/acre-yr: amendment cost \$72.00 per ton -- fine grind – solution grade
- Mode of application: water run – 2.5 acre-ft/acre
- Increases EC of the irrigation water from about 0.7 to 0.9 dS/m and decreases SAR from about 2.8 to 2.2.
- Disadvantage: water loss from unlined head ditch increased due to enhanced infiltration.

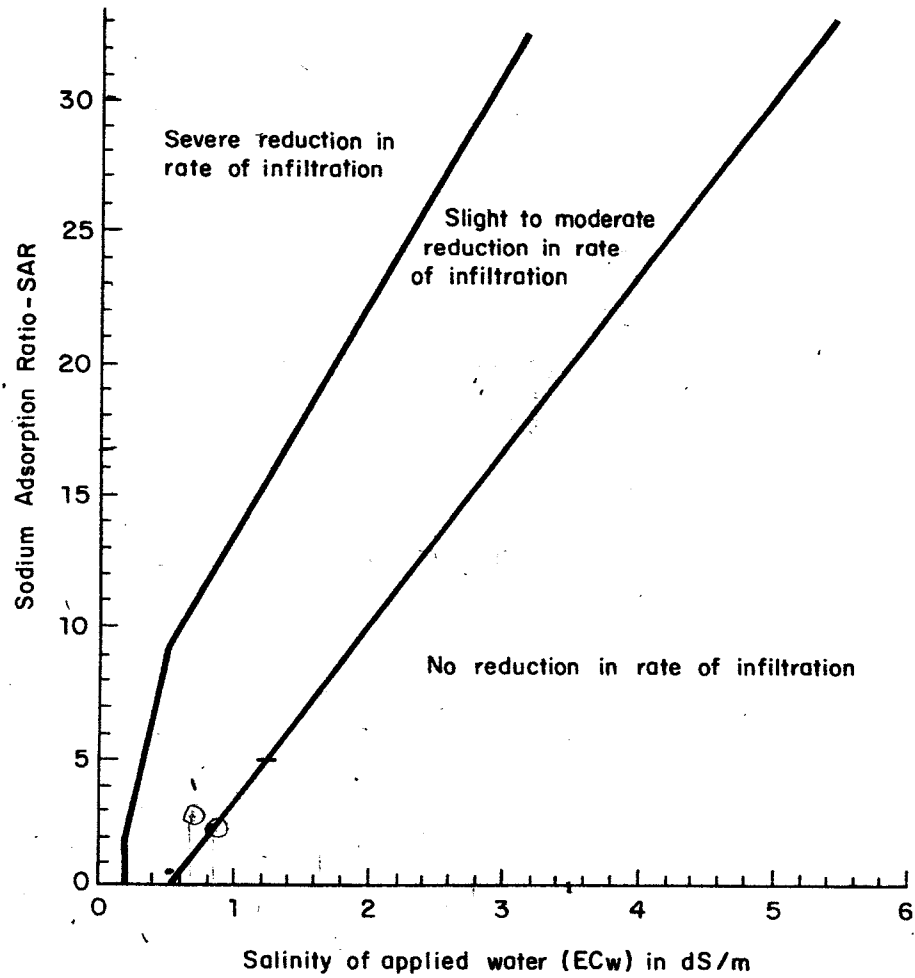


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Paso Robles study.

Where gypsum was applied to the soil surface

ponding did not occur after sprinkler irrigation of one inch of water



Paso Robles/infiltration- amendment study

irrigation water quality (EC = 0.8; SAR = 7)

Infiltration wasn't maintained by tillage after each irrigation, about half the water ranoff

Maintaining infiltration required surface applied gypsum, or intercropping with Blando Brome

Alternative amendments for gypsum **for calcareous soils**

- Sulfuric acid (\$100/ton)
 - 1 ton of acid equals 1.8 tons of gypsum
- Sulfur (70 – 75 \$/ton)
 - 1 ton of sulfur equals 5.3 tons of gypsum

Sulfuric acid – 93 % (\$100/ton)

- 1 ton/acre equals 1.8 tons of gypsum
- Application cost
 - Terrigator app.: \$5/ton
 - Tractor app. in orchards: \$15/ac
 - Tractor app. In vineyards: \$20/ac
 - Tractor app. on top of beds: \$17.50/ac

Sulfur 95+% pure (70 – 75 \$/ton)

- Oxidized by microbes: works when soil is warm. Apply in the Spring or Summer
- 1 ton/acre equals 5.3 tons of gypsum
- Freight distance less than 70 miles
 - \$6 –8/ton spreading costs for 0.5 T/ac
 - \$7 – 9/ton for 1.0 ton/ac
 - GPS controlled spreading – higher costs

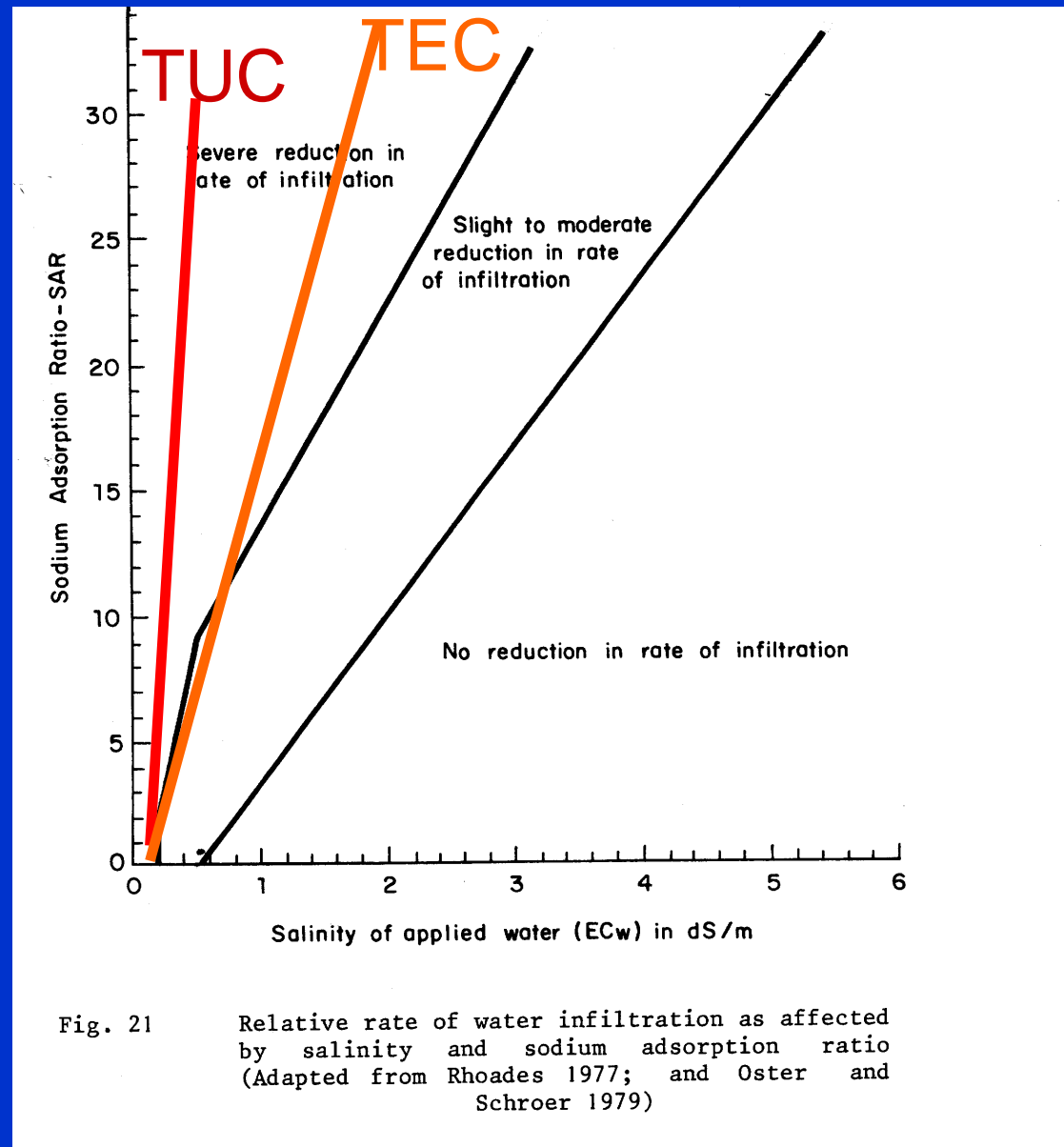
Reclamation of sodic soil

Hydraulic conductivities are less sensitive to the effects of low salinity and SAR than are infiltration rates.

TUC is the turbidity conc. The conc. when effluent from a saturated soil became turbid due to dispersed clay.

TEC is the Thres. Conc at which the sat. hyd. cond was reduced by 15 %.

Quirk and Schofield, 1955



Amendment requirements - Sodic soils

- Tons required per acre to replace 1 meq/100 g of exchangeable sodium in 6 inches of soil.
- GYPSUM: 0.86 tons
- Calcareous soils:
 - SULFURIC ACID: 0.49 tons
 - SULFUR: 0.16 tons
 - N-pH_{uric} 10/55: 0.5-0.9 tons

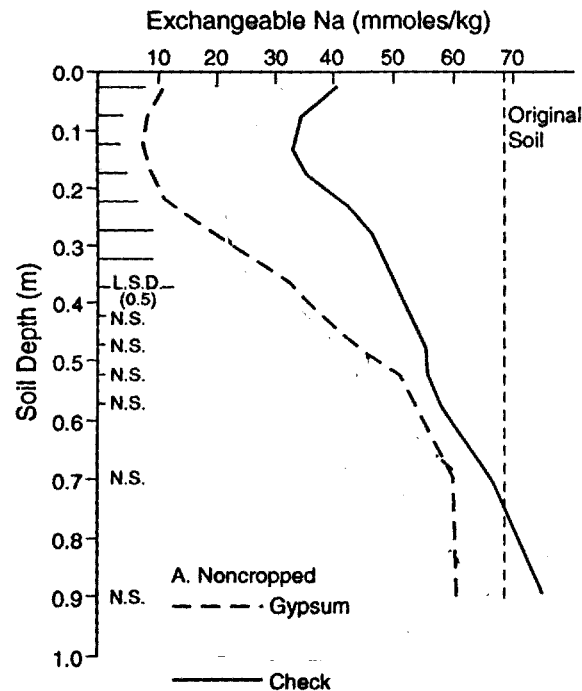
Reclamation by cropping

- Saline soil
- Sodic soil
 - Calcareous
 - Gypsiferous

Gypsum
incorporated into
the top 20 cm of
soil.

Irrigation plus
gypsum results in
reclamation
through the top 20
cm of soil.

RECLAMATION OF SALT-AFFECTED SOILS



Cropping plus irrigation:

Dissolution of soil lime throughout the rootzone.

Reclamation throughout the rootzone.

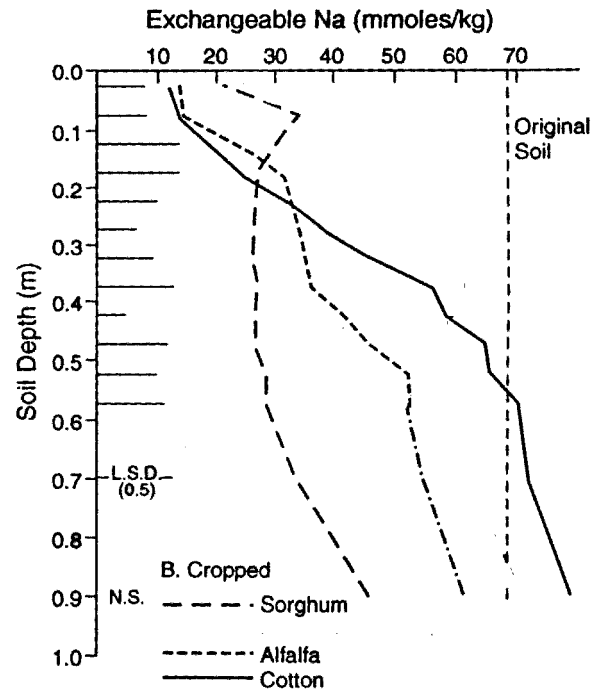


Fig. 19-8. Final distribution of exchangeable Na levels with soil depth resulting from reclamation treatments for noncropped (A) and cropped (B) treatments (Robbins, 1986).

Salinity and Sodicity Problems

- Prevention – select appropriate crops, maintain infiltration, take rainfall/snowmelt into account, control salinity and sodicity buildup through irrigation and rainfall.
 - Don't count on rainfall, compensate by extra irrigation if it doesn't occur.
- Correction (reclamation)
 - Prevent through good management
 - Requires water, sometimes also amendment,
 - cropping helps.

Reclamation is measured in tons,
prevention is measured in
knowledge

- Thanks for the opportunity
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