Department of Primary Industries

30+ years of research into the management of salinity and sodicity in irrigated Riverine Plains soils

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Why manage salinity and sodicity

Salinity – affects plant growth

Sodicity – affects soil aggregate stability

Root zone salinity needs to be < threshold levels for max plant growth

- Osmotic effect
- Specific ion toxicity
- Nutritional disorders

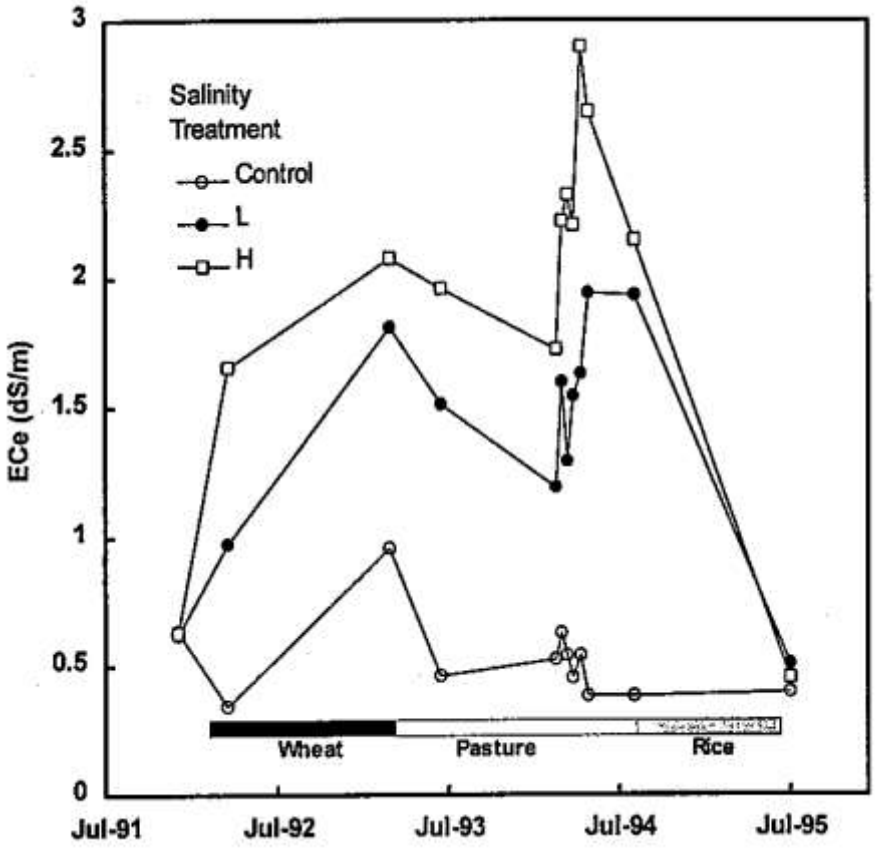
Sodicity affects soil – infiltration, hydraulic conductivity

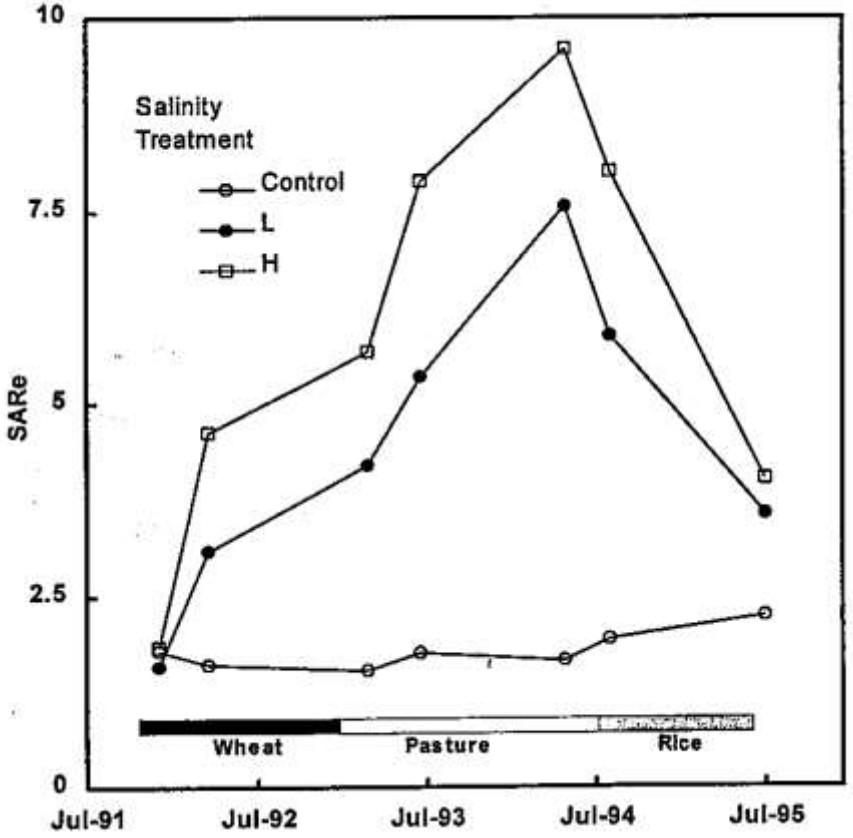
- If Na reaches levels that cause dispersion, then the ability to leach is lost.
- Salts then accumulate in the root zone to production limiting levels

Quirk & Schofield – Threshold Electrolyte Concentration

Salinity can only be managed when sodicity is managed

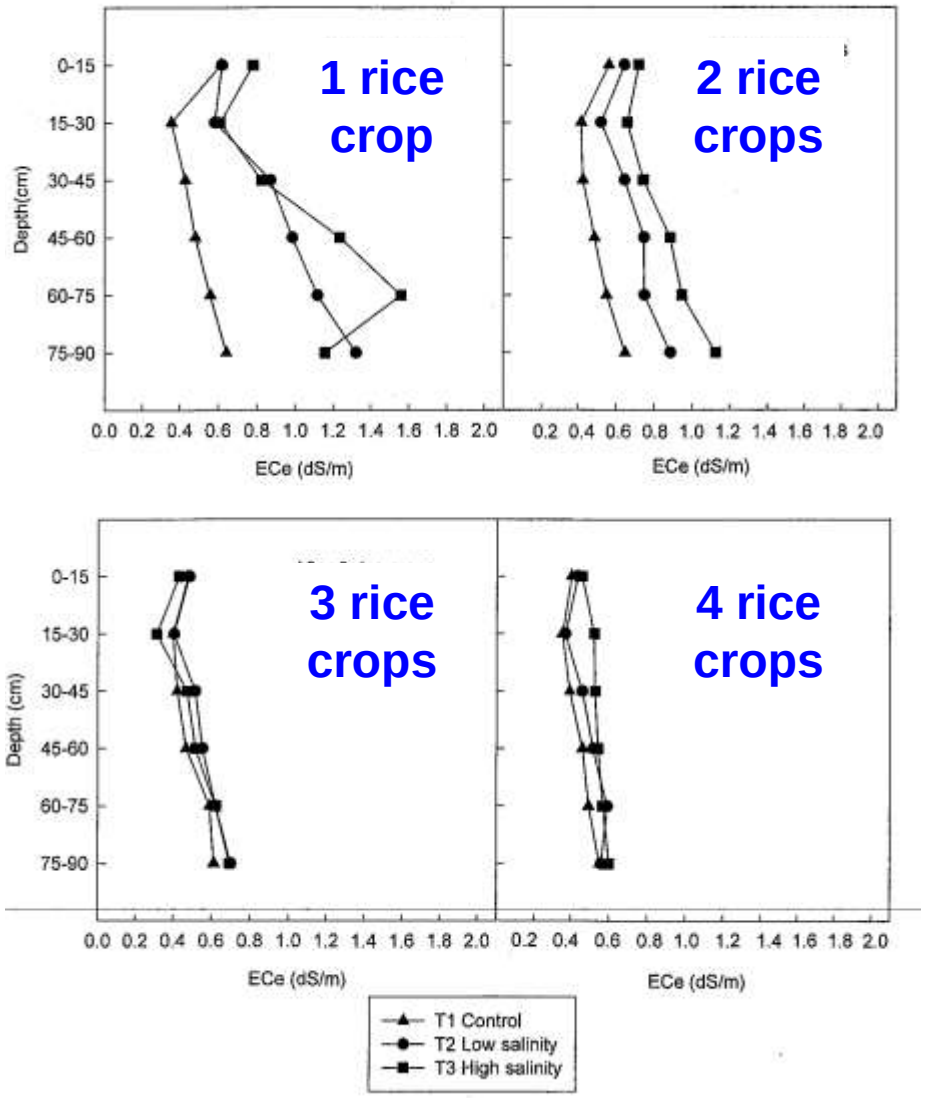
1. Leach salts – strategic leaching crop

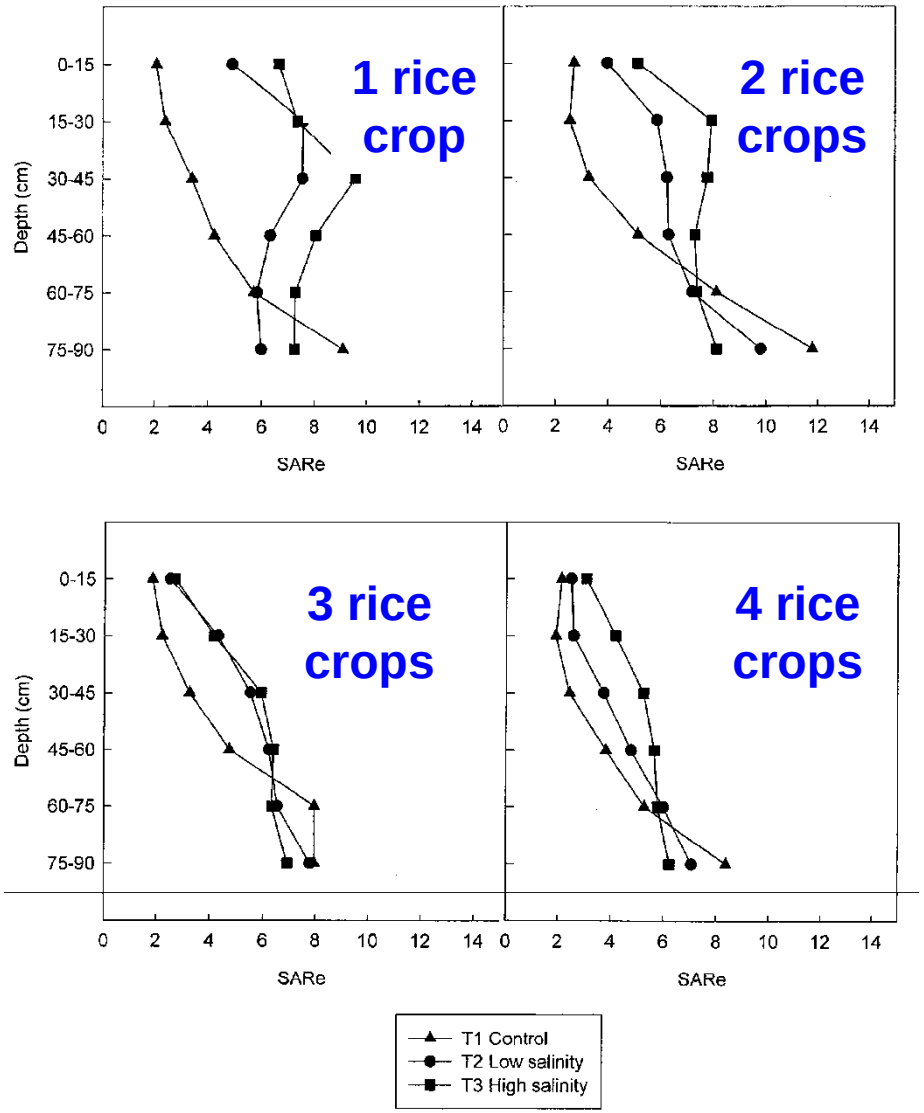




Thompson et al (1997) Final report for Project DAN8

Leach salts – effectiveness of fresh water





Thompson et al (1997) Final report for Project DAN8

Leach salts – irrigation strategies

Soil = red chromosol (RBE)

Crop = lucerne

3 years – GW irrigated

Alternating highly saline-sodic GW (6 dS/m; SAR 16) with CW did not affect infiltration

Season average applied water salinity may be used to estimate effects on soils and plants

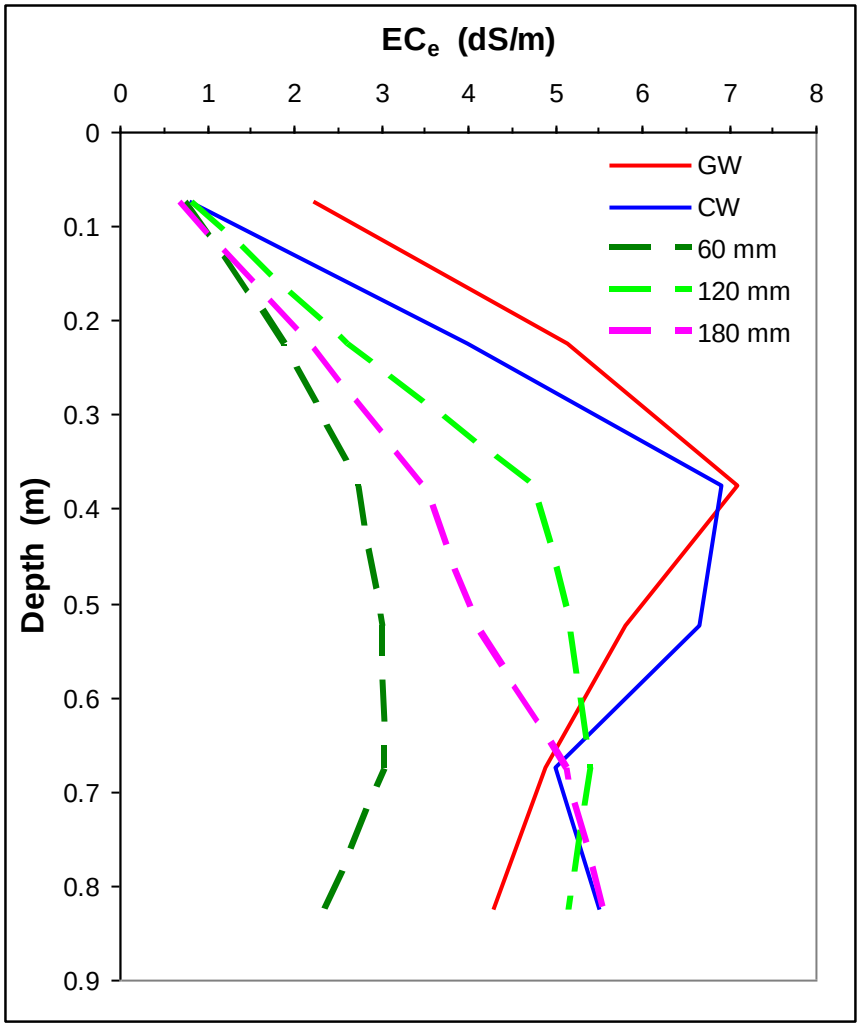
LF = 0.01 as shallow WT (1 m)

Followed by 2 years fresh water

60, 120 & 180 mm ET-R

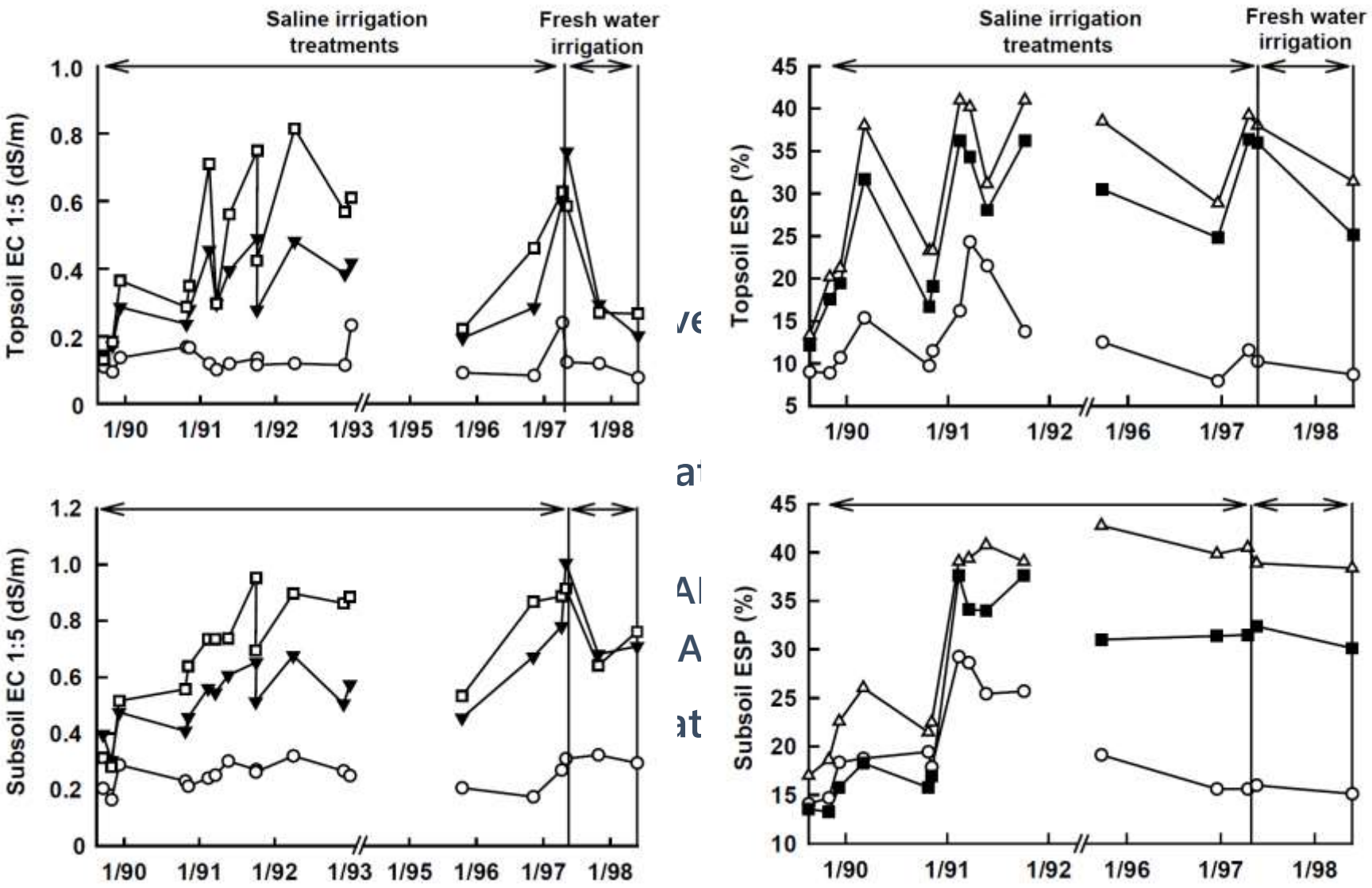
Leaching better with 180 cf 120

SAR same pattern but less affected



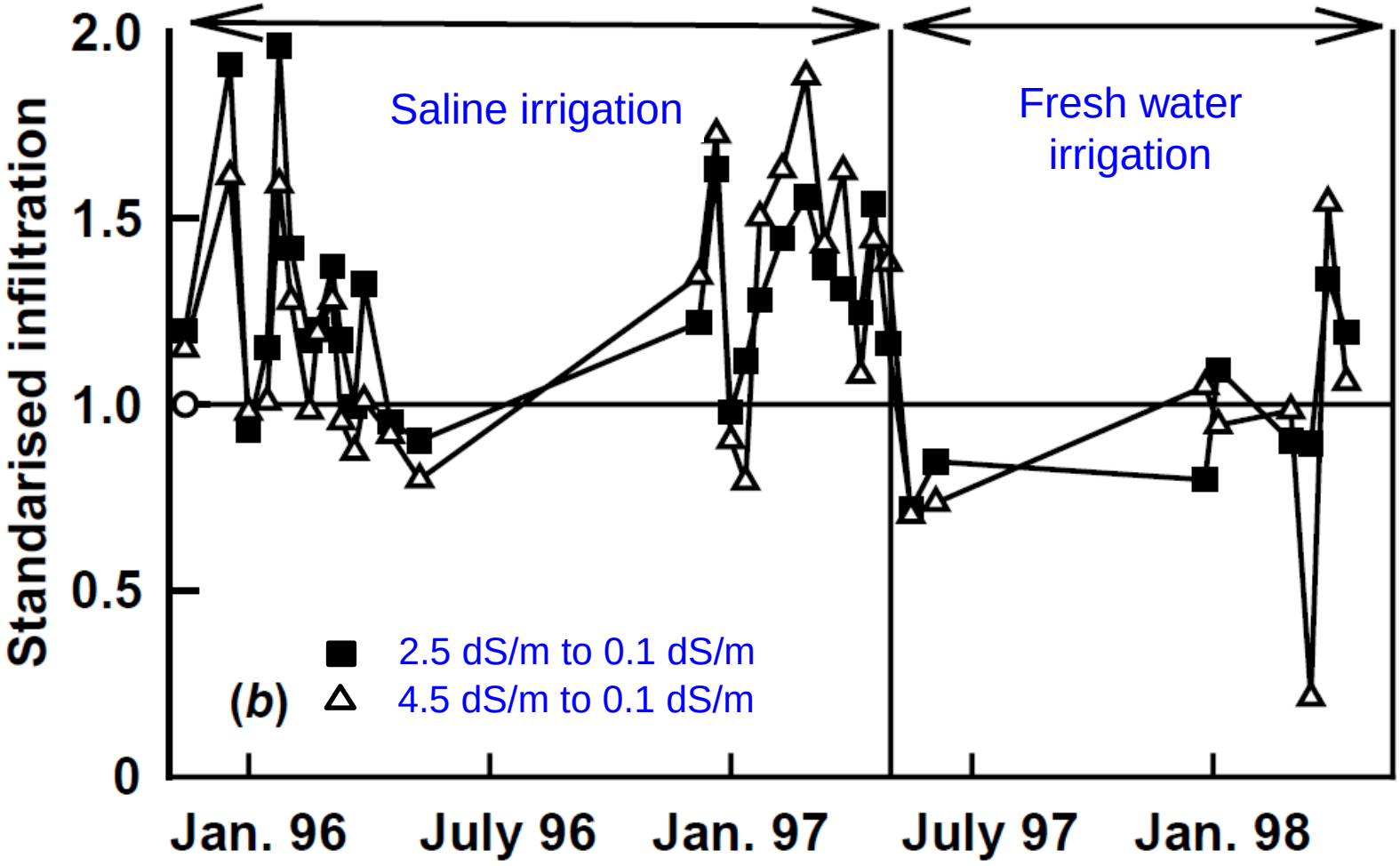
Slavich & Peterson (2002) AJEA **42**, 281-290
North & Thompson - unpublished

Leach salts – winter rainfall



Bethune & Batey (2002) AJEA.**42**; 273-279

2. Changing to lower EC water - pasture



Cultivating the pasture reduced infiltration to near zero

Bethune & Batey (2002) AJEA.**42**; 273-279

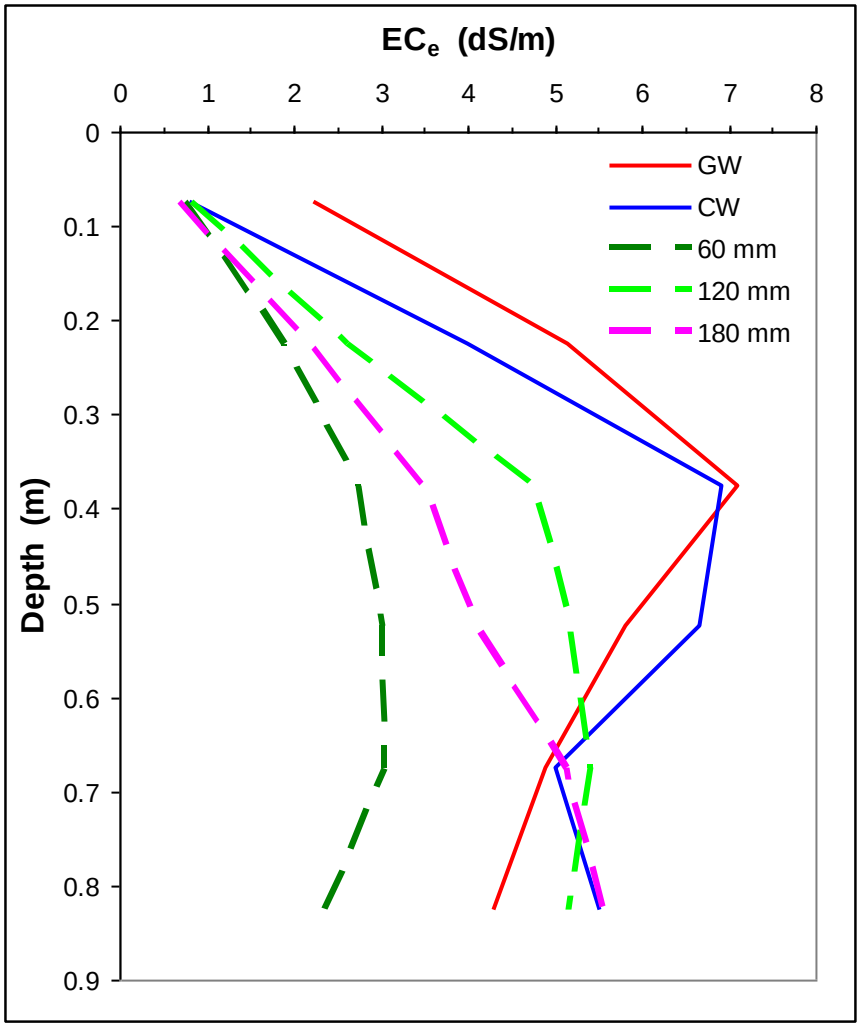
Changing to lower EC water - lucerne

Soil = red chromosol (RBE)
Crop = **lucerne**

No gypsum prior to fresh water
Water-table had dropped

The soil remained stable due to:

1. Soil type – loam topsoil
2. No cultivation – intact stand



Slavich & Peterson (2002) AJEA **42**, 281-290
North & Thompson - unpublished

3. Effectiveness of gypsum

Bridge (1968) - use of gypsum to maintain EC_{iw} > TEC

- Problem = pasture establishment on sodic soils
- Riv clay - ESP = 23; TEC = 1 dS/m; EC_{iw} = 0.1 dS/m
- Solution = water-run gypsum to raise EC_{iw} to 1 dS/m
- 75 mm irrigation = 0.6 t/ha gypsum *cf* 2-3 t/ha spread

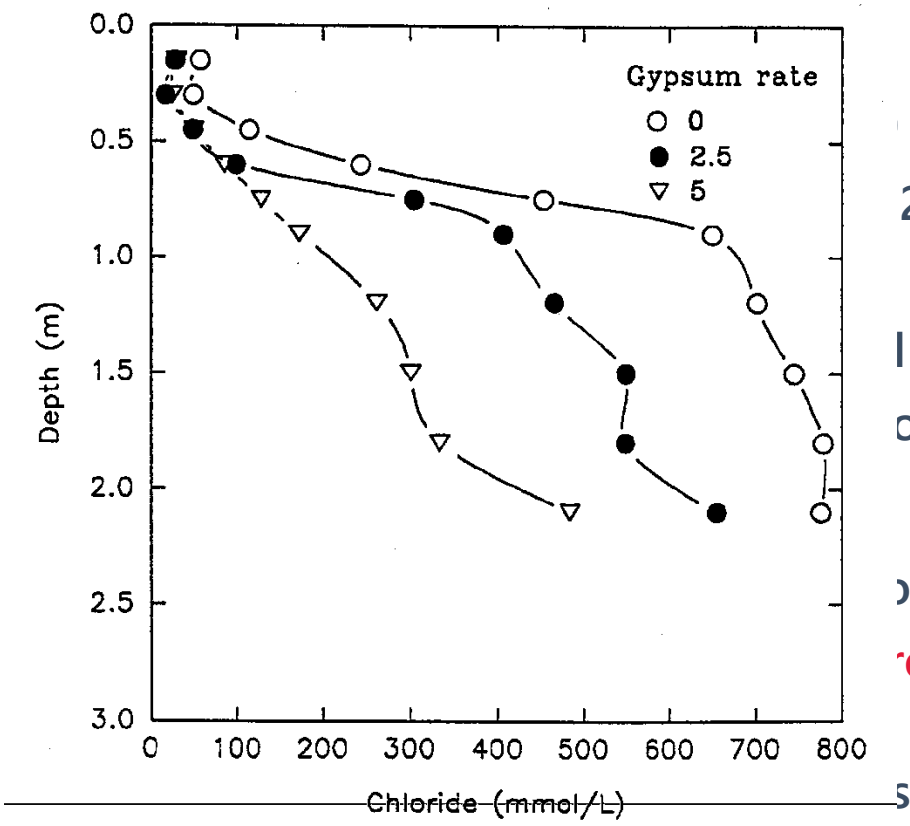
Mehanni & Bleasdale (1983)

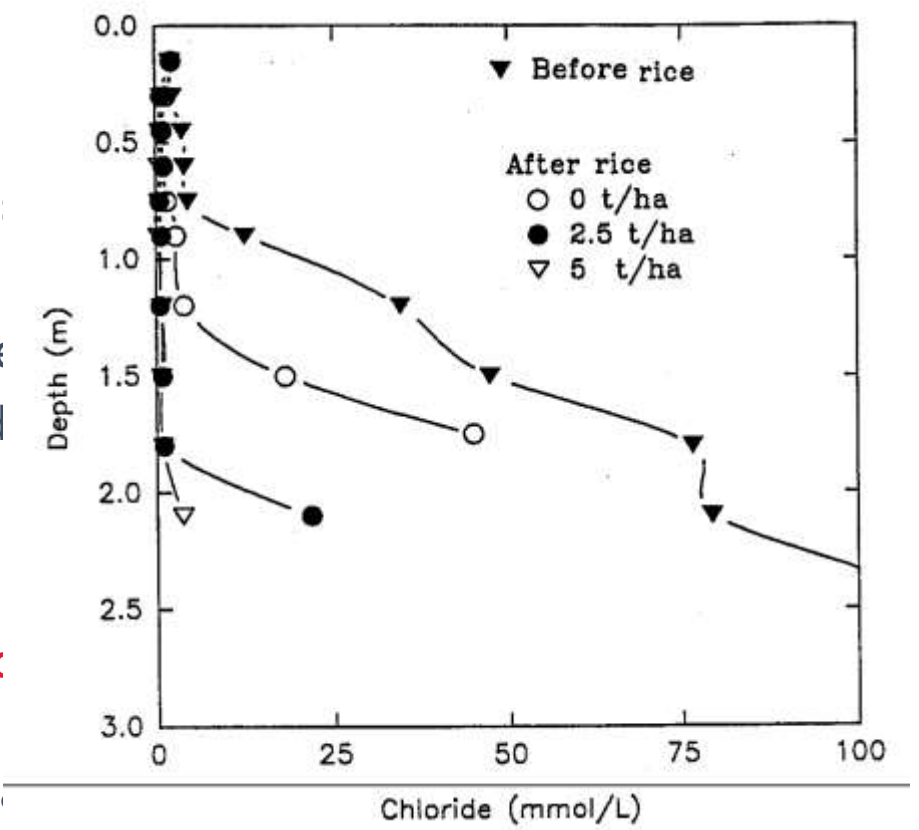
- High water-table under chromosol (A hor: 32% clay; ESP 8.3; EC_w 7.8 dS/m)
- Gypsum ONLY effective when water-tables controlled
- Decreased ESP (8.3 down to 3.7%)
- Increased hydraulic conductivity (1.12 to 24.4 cm/day), infiltration (by 40%;), Cl leaching (by 33%) and yields (by 30-45%)
- Ripping (alone or with gypsum) was of no benefit

Mehanni & Rengasamy (1990)

- no effect of gypsum if EC_{iw} > TEC (3.8 dS/m)

Effectiveness of gypsum



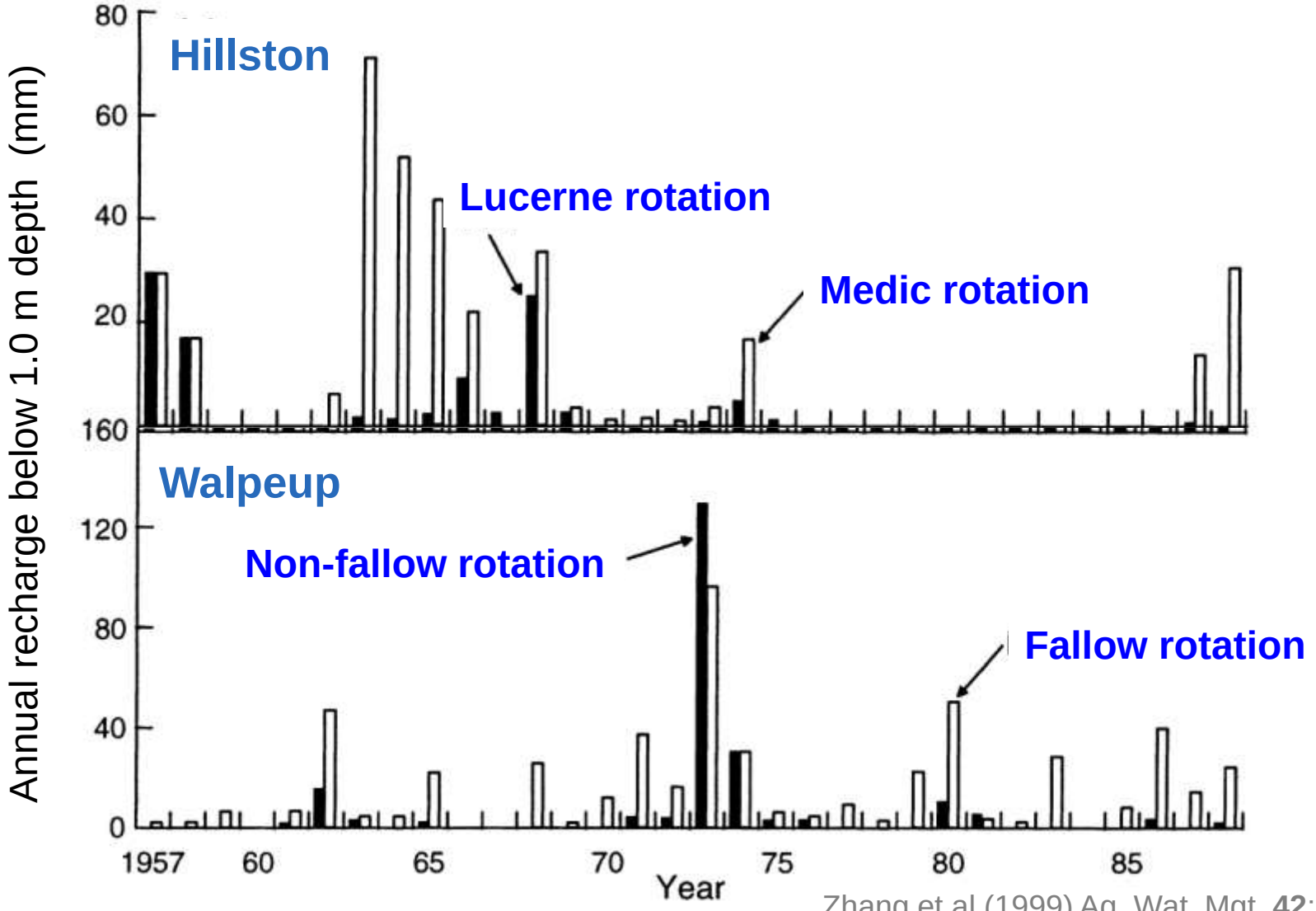


Highly saline, grey vertosol

Red sodosol

Greater leaching with light soils, high EC_{iw} & high gypsum rates

4. Effectiveness of rainfall

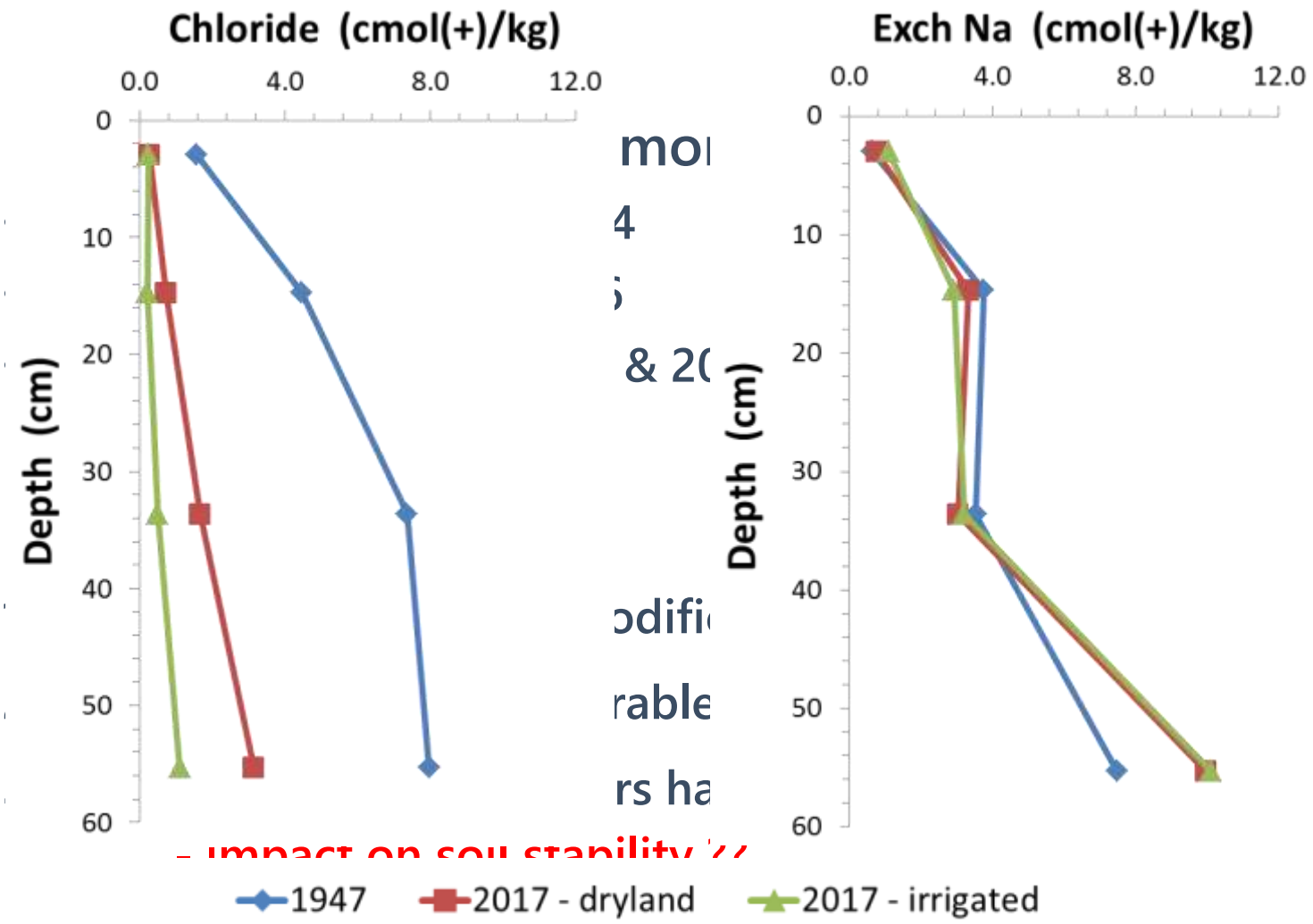


Zhang et al (1999) Ag. Wat. Mgt. **42**; 237-249

Recharge below the root-zone is episodic

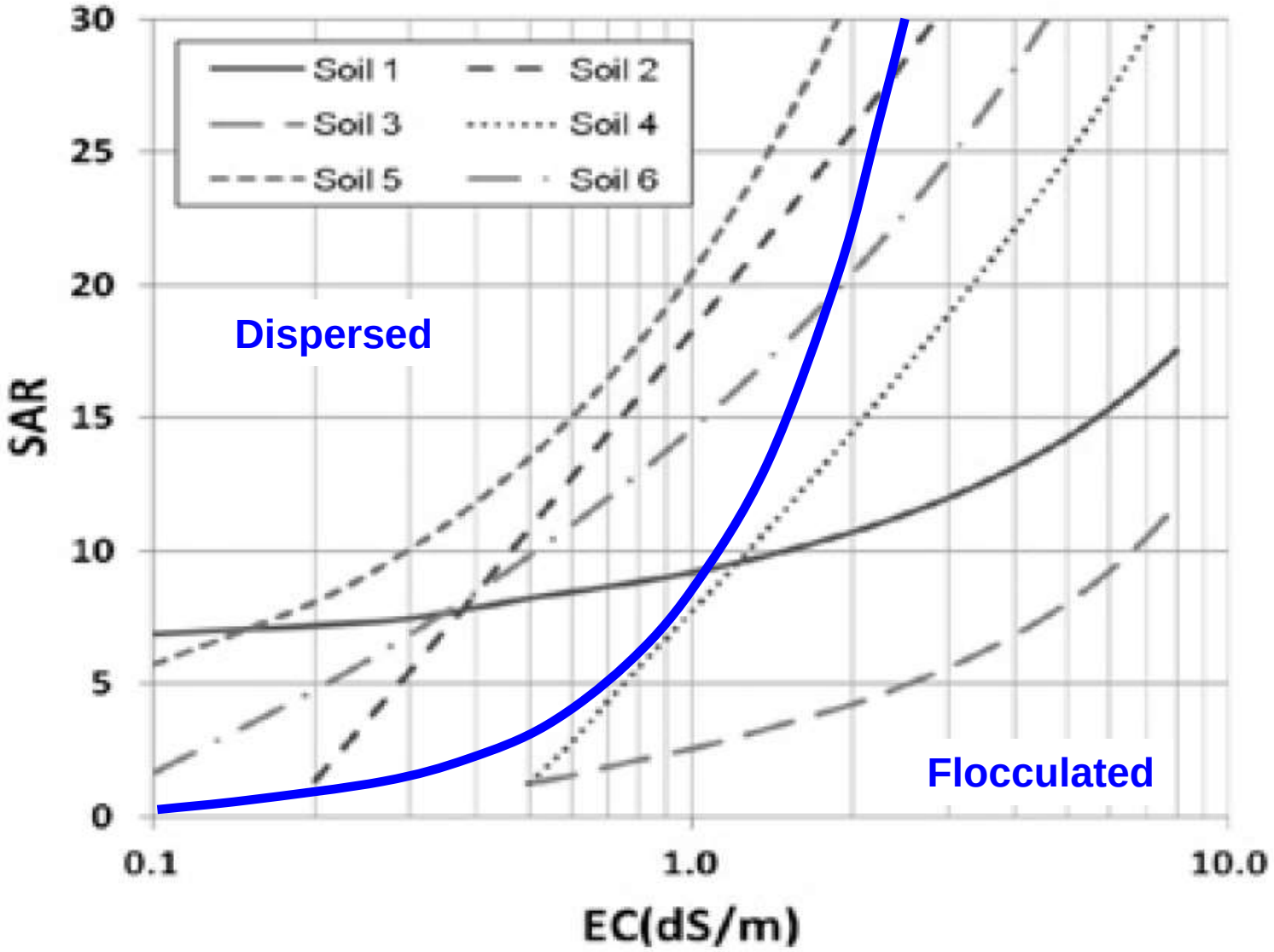
10% of annual recharge events account for 25-85% of long-term total recharge

Effectiveness of rainfall – soil monitoring



North et al (2018) Sth NSW Research results. NSW DPI

5. Effect of soil type - Queensland



Summing up

- Soil stability is dependent on: clay content, clay mineralogy, **organic matter, cultivation, EC & SAR**
- Control water-tables first
- Salinity can be managed by leaching with fresher water
- Na and dispersion can be managed with gypsum
- Winter rainfall can leach salts (climate change ?)
- Apply gypsum to dispersive soils **before** low EC water is applied (e.g. in autumn) – **water run gypsum??**
- Reclamation is possible - gypsum; summer leach crop; surface irrig

DO

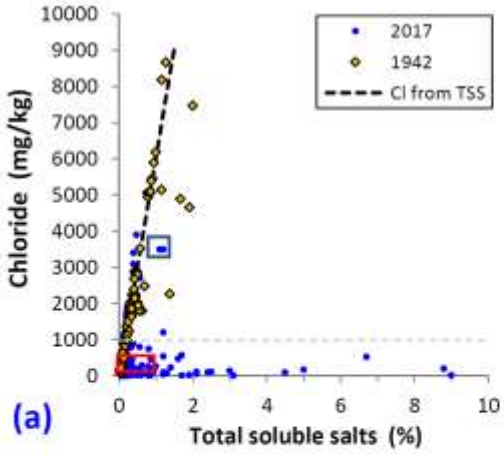
- Apply a leaching fraction (> 0.1)
- Adopt conservation farming

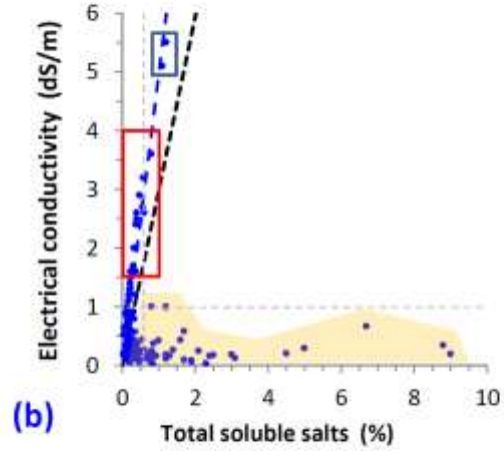
DO NOT

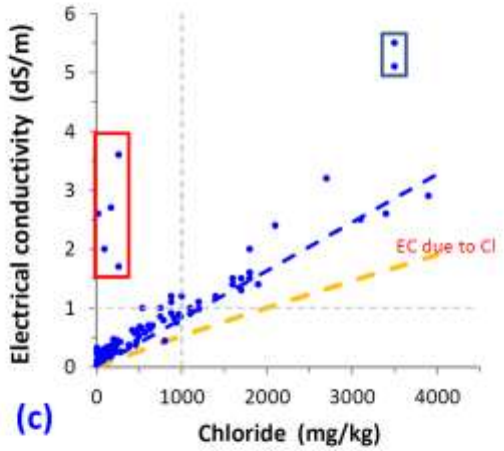
- Cultivate dispersive soils
- Bare fallow

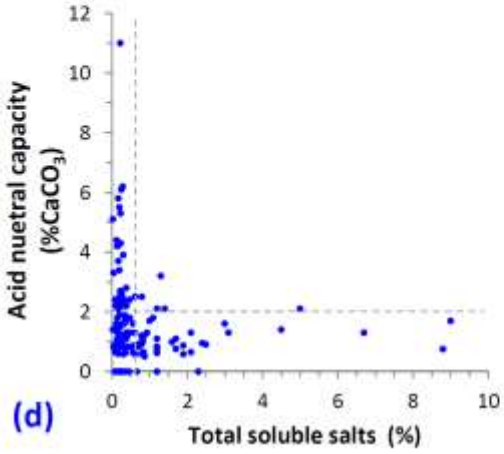
Two goals

1. Keep RZ salinity below production limiting thresholds
2. Ensure soils remain flocculated so salts can be leached









NOTES

- The black dashed line in **(a)** is the theoretical relationship between Cl and TSS% when the soluble salt is 100% NaCl.
- The black dashed line in **(b)** is the relationship $EC_{1:5}$ = TSS ÷ 0.336 (p. 22 of Rayment & Lyons, 2011) for soils dominated by NaCl.
- The blue dashed line in **(b)** is the relationship $EC_{1:5}$ = (TSS ÷ 0.336) × 0.6
- The orange dashed line in **(c)** shows the theoretical contribution of Cl^- salts to $EC_{1:5}$ (Shaw, 1995, page 83)
- The blue dashed line in **(c)** shows the total contribution of all salts to $EC_{1:5}$ when Cl^- salts contribute 60% of $EC_{1:5}$ (i.e. $EC_{1:5} = EC_{Cl} \div 0.6$)