Electrochemical Stability Index (ESI)

In the soil, exchangeable cation sodium (Na) leads to soil dispersion and thus loss of structure. This causes:

- Poor water infiltration rates
- Poor water holding capacity
- Poor oxygen supply to roots and soil life
- Poor nutrient use efficiency

In sodic soils (i.e. exchangeable sodium percentage (ESP) is above 6%), clay disperses less, as the salt concentration of the soil solution, measured as electrical conductivity (EC) or chloride (Cl) concentration, increases. On the other hand, sodic soil with a low salt concentration will disperse and loose structure easily. This is a common occurrence when rainwater falls upon sodic soil or low EC irrigation water is used.

A recently developed index which is increasingly being used to express the relationship between sodicity and salinity is the Electrochemical Stability Index (ESI).

The ESI is determined as the ratio of the electrical conductivity ($EC_{1:5}$ – dS/m) and the exchangeable sodium percentage (ESP = the sodium proportion of the cation exchange capacity, CEC) in a soil sample.

According to the Cotton CRC and NSW Agriculture, a tentative critical ESI value for Australian cotton soil is 0.05:
"An economically viable response to gypsum and/or lime can be expected where ESI values are at or below this level. To manage soil structural decline caused by excess sodium on the exchange complex, gypsum can be applied (calcium sulphate – $CaSO_4.2H_2O$). The best results will be achieved if the gypsum is dissolved prior to application.

The effect of the addition of gypsum in this way is two fold.
In the first instance, and because gypsum is a mildly soluble salt, the soil solution EC increases. The increase in soil solution salinity mitigates the impact of the high soil ESP. In the longer term the excess calcium entering the soil solution from the applied gypsum exchanges with the sodium and magnesium on the clay exchange sites. Both of these may be leached during subsequent irrigation or rainfall events. As a result, sodium and magnesium are removed with the calcium left behind to initiate the process of aggregation, thus improving soil structure."

Fast acting fertiliser products containing soluble calcium at much higher levels than gypsum or lime can be used to exchange sodium with calcium without increasing the soil solution salinity.

Saline and sodic soils greatly benefit form the addition of organic matter. This can be done via growing green crops, maintaining crop residues, importing manures and other organic materials or using good quality humic acids.

Critical ESI values for crops other than cotton still have to be determined. Until then, the tentative ESI value of 0.05 will be adopted.