Management of Salinity and Sodic Soils under Irrigation

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Fig. 2. Distribution of sodic soils with variable exchangeable sodium percentage (ESP) at 0.2–0.3 m depth within part of the Burdekin River Irrigation Area.
Table 1. Criteria used in the BRIA to assess the sodicity limitation for sugarcane based on field pH and predicted ESP for Vertosols and Sodosols

<table>
<thead>
<tr>
<th>Predicted ESP (%)</th>
<th>Field pH at 0.3 m</th>
<th>Yield reduction (%)</th>
<th>Sugarcane sodicity sub.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertosols</td>
<td>Sodosols</td>
<td></td>
</tr>
<tr>
<td>&lt;6</td>
<td>&lt;8.0</td>
<td>&lt;6.5</td>
<td>negligible</td>
</tr>
<tr>
<td>6–14</td>
<td>8.0–9.5</td>
<td>6.5–8.0</td>
<td>10–25</td>
</tr>
<tr>
<td>15–25</td>
<td>8.0–8.5</td>
<td>25–50</td>
<td>S03</td>
</tr>
<tr>
<td>&gt;25</td>
<td>&gt;8.5</td>
<td>&gt;50</td>
<td>S04</td>
</tr>
</tbody>
</table>
## Table 6. The extent (ha and %) of Sodosols in Survey Sections of the BRIA

<table>
<thead>
<tr>
<th>Survey Section</th>
<th>Area (ha) and % of each Section with ESP (0.3 m) of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6–14</td>
</tr>
<tr>
<td>Haughton North</td>
<td></td>
</tr>
<tr>
<td>(5036 ha)</td>
<td>1150</td>
</tr>
<tr>
<td></td>
<td>(23%)</td>
</tr>
<tr>
<td>Haughton Central</td>
<td></td>
</tr>
<tr>
<td>(4378 ha)</td>
<td>713</td>
</tr>
<tr>
<td></td>
<td>(16%)</td>
</tr>
<tr>
<td>Haughton South</td>
<td></td>
</tr>
<tr>
<td>(4148 ha)</td>
<td>1204</td>
</tr>
<tr>
<td></td>
<td>(29%)</td>
</tr>
<tr>
<td>Jardine</td>
<td></td>
</tr>
<tr>
<td>(5730 ha)</td>
<td>1219</td>
</tr>
<tr>
<td></td>
<td>(21%)</td>
</tr>
<tr>
<td>Northcote</td>
<td></td>
</tr>
<tr>
<td>(7820 ha)</td>
<td>2485</td>
</tr>
<tr>
<td></td>
<td>(32%)</td>
</tr>
<tr>
<td>Mulgrave</td>
<td></td>
</tr>
<tr>
<td>(8580 ha)</td>
<td>1428</td>
</tr>
<tr>
<td></td>
<td>(17%)</td>
</tr>
<tr>
<td>Leichhardt Downs</td>
<td></td>
</tr>
<tr>
<td>(9650 ha)</td>
<td>1672</td>
</tr>
<tr>
<td></td>
<td>(17%)</td>
</tr>
<tr>
<td>Leichhardt Downs</td>
<td></td>
</tr>
<tr>
<td>Relift (1968 ha)</td>
<td>442</td>
</tr>
<tr>
<td></td>
<td>(22%)</td>
</tr>
<tr>
<td><strong>Total 47 310 ha</strong></td>
<td><strong>10 313</strong></td>
</tr>
<tr>
<td><strong>Percent of total</strong></td>
<td><strong>(22%)</strong></td>
</tr>
</tbody>
</table>
7.1 IRRIGATION AND SODICITY: AN OVERVIEW

P. Rengasamy A and K.A. Olsson B

ABSTRACT

The productivity of irrigated agriculture in Australia is low for most crops and important factors are the physical and chemical constraints caused by sodicity in the rootzone. Over 80% of the irrigated soils are sodic and have a degraded structure which limits water and gas transport and root growth. Irrigation, without appropriate drainage, leads to the buildup of salts in soil solutions with increased sodium adsorption ratio and can develop perched watertables due to a very low leaching fraction of the soil layers exacerbated by sodicity. Therefore, irrigation management in Australia is closely linked with the management of soil sodicity.

The inevitable consequence of continued irrigation of crops and pastures with saline-sodic water without careful management is the further sodification of soil layers and concentration of salt in the rootzone. This will increase the possibility of dissolving toxic elements from soil minerals. The yields of crops can be far below the potential yields determined by climate. The cost of continued use of amendments and fertilizers to maintain normal yields will increase under saline-sodic irrigation.

Most of the irrigated soils in Australia need reclamation of sodicity of soil layers at least in the rootzone. The management of these sodic soils involves the application of gypsum, suitable tillage and the maintenance of structure by the buildup of organic matter and biological activity over time. Then artificial drainage, an essential component of the management of irrigated sodic soils, is possible. By following these soil management practices, irrigated agriculture in Australia will become sustainable with increased yields and high economic returns.

Keywords: irrigated soils, sodicity, sodification, Na balance, sodic soils, soil management
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Fig. 4. Specification of hydrologic components and soil parameters for sodic and ameliorated soils.
Figure 1.3 Threshold electrolyte concentration (TEC) curve illustrating zones of stable and unstable permeability [Quirk and Schofield, *J. Soil Sci.* 6:163-178, (1955)].
SAR vs EC (dS m\(^{-1}\))

- **Sodic Soils**
- **Saline Sodic Soils**

**Equations**:

- \( EC = 0.056SAR + 0.06 \) for spontaneous dispersion
- \( EC = 0.121SAR + 0.33 \) for mechanical dispersion
The graph illustrates the relationship between SAR (Sodium Adsorption Ratio) and EC (Electrical Conductivity) for decreasing permeability. The equations for the two curves are:

1. \( \text{SAR} = 28.065 \text{EC}^{0.5} - 9.068 \)
2. \( \text{SAR} = 20.088 \text{EC}^{0.5} - 16.112 \)

The interface between the two permeability regions is shown as a dashed line. The graph indicates that as SAR increases, the permeability decreases significantly.
Fig. 13. Soil profile data for the 0.9 m depth for some 900 soil profiles from Queensland plotted against the relationships of Ayers and Westcot (1985) as described in Figure 12a.
Figure 1.4 Hydraulic conductivity of silty loam soil (Sawyers Field 1, Rothamsted Farm, England) as a function of electrolyte concentration for several levels of exchangeable sodium percentage (ESP) [Reeve, Trans. 5th Int. Congr. Aoric Enq. pp. 21-32. (1958)].
Fig. 3. Average rootzone SAR₀ as influenced by leaching fraction and SARᵢw.
Fig. 4. Specification of hydrologic components and soil parameters for sodic and ameliorated soils.

**Sodic Soils**
- Rain
- Irrigation
- Runoff

**Ameliorated Soils**
- Rain
- Irrigation
- Runoff

**SAR_{1:5} > 3**
**EC_{1:5} < 0.4 dS m^{-1}**
**LF < 0.1**
Strength > 1 MPa
Aeration Porosity < 15%
Matrix water retention < 12 mm dm^{-1}

**SAR_{1:5} < 3**
**EC_{1:5} > 0.4 dS m^{-1}**
**LF > 0.1**
Strength < 1.0 MPa
Aeration Porosity > 15%
Matrix water retention > 12 mm dm^{-1}

Leaching through cracks
Runoff > Leaching

Leaching through matrix
Runoff < Leaching

Artificial drainage

Recharge to groundwater
The evidence from best management of surface soils through stubble retention and minimum till indicates that these managements will maximize water storage. This is at the cost of greater water movement below the root zone and for some landscapes degradation due to salinity and/or waterlogging. Some quantitative research on the interaction of surface soil protection and implications for soil and landscape hydrology is needed.
LEAKAGE INTO LANDSCAPE FROM BENEATH AGRICULTURE

15 to 150 mm/yr

DRAINAGE FROM LANDSCAPE

0.5 to 5 mm/yr

Rainfall
Transpiration
Irrigation
Interception
Evaporation
Run-off

Drainage

WATERTABLE
DRAINAGE FROM LANDSCAPE FROM BENEATH AGRICULTURE

15 to 150 mm/yr

LEAKAGE INTO LANDSCAPE FROM BENEATH AGRICULTURE

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DRAINAGE FROM LANDSCAPE

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Rainfall
Transpiration
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Interception
Evaporation
Run-off
Drainage
LEAKAGE INTO LANDSCAPE FROM BENEATH AGRICULTURE

15 to 150 mm/yr

DRAINAGE FROM LANDSCAPE
0.5 to 5 mm/yr
Leakage of water drives leaching of nutrient and accelerated acidification as well as salinity.
Landcare Farming

Catchment Action Plan
Sustainable Irrigation in Australia

- Management of Sodic Soils
- Management of salt...mobilisation, storage and transport to where it came from...the sea
- Balancing water entry, storage and leakage from soil along with salt, nutrients and pesticides
- Management must address paddock to farm to catchment...whole system