1985

Saltland Drainage: case studies

P.R. George
R.A. Nulsen

Follow this and additional works at: http://researchlibrary.agric.wa.gov.au/journal_agriculture4

Part of the Hydrology Commons, and the Soil Science Commons

Recommended Citation

This article is brought to you for free and open access by Research Library. It has been accepted for inclusion in Journal of the Department of Agriculture, Western Australia, Series 4 by an authorized administrator of Research Library. For more information, please contact jennifer.heathcote@agric.wa.gov.au, sandra.papenfus@agric.wa.gov.au.
IMPORTANT DISCLAIMER

This document has been obtained from DAFWA's research library website (researchlibrary.agric.wa.gov.au) which hosts DAFWA's archival research publications. Although reasonable care was taken to make the information in the document accurate at the time it was first published, DAFWA does not make any representations or warranties about its accuracy, reliability, currency, completeness or suitability for any particular purpose. It may be out of date, inaccurate or misleading or conflict with current laws, polices or practices. DAFWA has not reviewed or revised the information before making the document available from its research library website. Before using the information, you should carefully evaluate its accuracy, currency, completeness and relevance for your purposes. We recommend you also search for more recent information on DAFWA's research library website, DAFWA's main website (https://www.agric.wa.gov.au) and other appropriate websites and sources.

Information in, or referred to in, documents on DAFWA's research library website is not tailored to the circumstances of individual farms, people or businesses, and does not constitute legal, business, scientific, agricultural or farm management advice. We recommend before making any significant decisions, you obtain advice from appropriate professionals who have taken into account your individual circumstances and objectives.

The Chief Executive Officer of the Department of Agriculture and Food and the State of Western Australia and their employees and agents (collectively and individually referred to below as DAFWA) accept no liability whatsoever, by reason of negligence or otherwise, arising from any use or release of information in, or referred to in, this document, or any error, inaccuracy or omission in the information.
SALTLLAND DRAINAGE: case studies

Over the past five years farmers have become increasingly interested in the use of drainage to overcome saltland problems.

Experimental work by the Department of Agriculture on sub-surface drainage includes tube drainage and drainage by pumping. The Department is also monitoring the performance of open drains installed by farmers. Major sites are at Esperance, Dalwallinu, Namban and Watheroo.

Some of these projects have been reported in an earlier issue of the Journal of Agriculture. In this article P. R. George, Research Officer and R. A. Nulsen, Principal Research Officer with the Salinity and Hydrology Research Branch, discuss recent results from tube drainage experiments at Esperance, Dalwallinu and Namban and pumped drainage trials at Dalwallinu and Frankland.

Tube drainage

Esperance Downs Research Station

Two drainage projects are at Esperance Downs Research Station, both on typical sand over gravelly clay sandplain soils.

- Site 1 is a hillside seepage with granite bedrock two to three metres below the surface. Tube drains were installed in April, 1981.
- Site 2 is a broad flat depression with bedrock about 10 m below the surface. Tube drains were installed in April, 1984.

The drainage design details and costs are shown in Table 1.

Costs at Site 2 included $4,200 for the electricity supply, sump and pump to discharge drainage water. The cost per hectare for Site 2 was less in 1984 because of cheaper installation methods and wider drain spacings. A trencher was used at Site 1 whereas at Site 2 drainage tubing was installed by the trenchless method using a large pipe layer.

Table 2 shows results from the drainage experiment at Site 1.

At Site 2, total drainage water discharged in 1984 was 9,500 cubic metres, an equivalent depth of 52 millimetres of water. The drainage water contained 18,000 milligrams/litre total soluble salts, thus 170 tonnes of salt was removed from the 18 hectares.
Table 2. Results from drainage at Site 1, Esperance Downs Research Station

<table>
<thead>
<tr>
<th>Year</th>
<th>Rainfall (mm)</th>
<th>Drain flow (cubic metres/year)</th>
<th>Salt removal (tonnes/year)</th>
<th>Crop yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual</td>
<td>Growing season</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>395</td>
<td>323</td>
<td>2,000</td>
<td>40</td>
</tr>
<tr>
<td>1982</td>
<td>443</td>
<td>354</td>
<td>1,300</td>
<td>21</td>
</tr>
<tr>
<td>1983</td>
<td>427</td>
<td>189</td>
<td>1,300</td>
<td>21</td>
</tr>
<tr>
<td>1984</td>
<td>511</td>
<td>373</td>
<td>3,300</td>
<td>45</td>
</tr>
</tbody>
</table>

Site 2 has been cultivated and sown to barley for the 1985 season. Yield from this and subsequent crops will be used as a final measure of the success of this project.

Important aspects of this study are:

- Sandplain hillside seeps can be reclaimed with tube drains at about 40 m spacings.
- Drains can be installed effectively and more cheaply by the trenchless method.
- Good yields of barley were obtained, although waterlogging problems can still occur with lupins.
- Because of low grades, pumping of drain effluent may be required.

Dalwallinu

The Dalwallinu site is a ‘typical’ salt-affected valley soil in the Western Australian wheatbelt. Red-brown sandy loam surface soil overlies poorly permeable clay sub-soils. Groundwater is shallow and extremely saline. The area, previously the most productive on the farm, became progressively more saline from about 15 years after clearing. It was virtually bare before treatment began.

Tube drains 65 mm in diameter were installed in April, 1983 by the trenchless method and spacings of 15 m, 30 m, 60 m and 120 m compared. Tube drains discharge into a 2.5 m deep open collector drain and drainage water is lifted to a shallow surface drain by a windmill equipped with a 150 mm diameter pump. A levee prevents surface water from flowing into and damaging the collector drain. The area has been fenced and surface water management improved by the use of grade banks on the surrounding slopes and by improved on-site surface drainage.

Water flows from the tube drains have been very low, as could be expected from the low permeability of the soils. Drains only flow after rainfall, indicating that little upward seepage occurs at this site.

Plant cover has improved significantly, but this could be attributable to reduced grazing pressure and better surface water management. Strips of barley sown across the site in 1983 and 1984 have yielded poorly. Surveys show that some reduction in surface salinity has occurred over the 15 and 30 m spacings, indicating that slow reclamation is occurring in these areas.

Important aspects of this study are:

- Preliminary indications are that tube drainage of such heavy and severely salinised soils is unlikely to be economical.
- Drain spacings of 15 to 30 m may be required and even then reclamation will be slow.
- Current costs of installing tube drains at 30 m spacings are about $700/ha, plus the cost of effluent disposal works. Improvement of the surface soil by gypsum application will be required.

Namban

The Namban drainage project is in association with the Watheroo-Coomberdale Soil Conservation District. The seven-hectare site carries poor barley grass pasture, is moderately saline and prone to severe waterlogging. The surface soil is a loamy sand and overlies a sandy clay sub-soil. An impermeable, hard clay layer about 10 centimetres thick occurs on top of the sub-soil and this reduces rainfall infiltration. At about 1.6 to 1.8 m depth a sandy layer occurs which is relatively permeable. In summer the saline watertable is about 0.8 m below the soil surface.

In March, 1984, 65 mm diameter tube drains were installed at 25 and 50 m spacings by the trenchless method using a Badger Plow. Drains
were installed 1.7 to 2.0 m deep into the sandy sub-soil horizon at a grade of 0.15 per cent. The drains discharge into an open collector drain which can also receive excess surface water through piped inlets.

In the first 100 days after installation, flow from the 50 m spacing area was 430 cubic metres/ha (43 mm) and salt removal was 5.5 t/ha. Water levels dropped about 0.5 m within 20 days of the drains being installed.

Costs were $420/ha (50 m spacing) comprising $2.10 for pipe and installation and $20/ha for levelling the ridges created during pipe installation. Additional costs were for the open collector drains at between $1200 to $1500/km.

Important aspects of this study are:
• Drains 50 m apart appear to be lowering the watertable effectively. The final proof of reclamation, however, will depend on subsequent cropping performance.
- Careful site investigation identified the cause of waterlogging—an impermeable hard clay layer—and the presence of a permeable layer into which drains should be installed. The presence of this permeable layer is the main reason why the drains have been effective.
• The hard clay layer will have to be cultivated and treated with gypsum to improve rainfall infiltration. Without this treatment the site will probably still be prone to waterlogging after heavy rains despite the presence of the drains and lowered watertables.

Pumped drainage
Dalwallinu

The soil and ground water conditions of the pumped drainage site at Dalwallinu are similar to those described previously for the tube drainage site in that area.

A bore was drilled 35 m to bedrock, lined with slotted 100 mm diameter PVC, gravel packed and developed. Initial testing showed that the bore would safely yield 300 cubic metres of water a day and that the aquifer hydraulic conductivity was relatively high (one metre a day). The groundwater contained 25000 to 30000 milligrams per litre of salt and would thus be highly corrosive.

The bore was then equipped with a special stainless steel submersible pump, and long-term continuous pumping started at a rate of 260 to 280 cubic metres of water a day. The effects of the pumping on watertable levels and pressure levels in the deeper groundwater were monitored.

After about 70 days of pumping, projections showed that pressure levels would be influenced about 800 m from the bore. By contrast significant effects on the watertable level were detected about 200 to 250 m from the bore. Although pressures in the more permeable deep
Acknowledgements
The Wheat Industry Research Council of Western Australia and the State Assistance Fund to Soil Conservation Districts have provided funding for drainage research. Goldfields Contractors Pty Ltd, Watheroo Salt Drainage Co and Wigmores Ltd provided valuable assistance in the development and proving of the trenchless method for installing drainage tubing. CSBP and Farmers and Humes (Plastics) Ltd have donated equipment and materials used in the programme. Houghton Wines have equipped and maintained the Frankland site.

The assistance and co-operation of the farmers on whose properties some of the experimental sites are located is greatly appreciated.

L. Lenane, T. Cooper, J. Doust, W. Pearson and S. West of the Department of Agriculture have provided valuable technical assistance.

Further reading

When to drain
The five case studies emphasise that each proposal for drainage should be treated on its merits. Careful site investigation is needed to assess the feasibility of drainage and to determine whether special treatment will be needed to improve soil structure.

The decision to drain or not should be made with the value of the assets that you wish to protect in mind. Where the choice exists it is wise policy to treat areas which are marginally saline, waterlogged or both, or areas which are just starting to become saline rather than those that are highly salt-affected and can only be reclaimed at great cost.

Aquifer are lowered, the low permeability of the upper four metres of clay soil thus restricts the downward 'leakage' of the watertable.

Important aspects of this study are:
- Careful investigation is required to ensure that high pumping rates can be sustained.
- Though longer testing is required it seems that about 20 ha could be reclaimed for an initial cost of about $350/ha. With continuous pumping, yearly power costs alone are currently about $120/ha.
- On this severely saline site gypsum will probably be needed to improve soil structure. Two to three years must elapse before enough salt is leached from the soil to allow cropping.
- A larger bore, which would enable higher pumping rates, may have increased the treated area, spread the capital costs over a wider area and reduced the running costs per hectare. A less severely degraded site with more permeable surface soils could be reclaimed faster and with lower soil improvement costs.
- Unless longer periods of pumping increase the area drained, pumped drainage at this site appears uneconomical. However, the results are encouraging enough to indicate that it may be effective at other sites or in other applications, for example to control saline seepage into an irrigation water supply.

Frankland
At 'Westfield', Frankland, the problem was increasing salinity of dam water used for irrigating a vineyard.

The main input of salts was from a seep upslope from the dam where water containing 7 500 mg/L of salt was seeping upwards at a rate of seven millimetres a day. Although the active seepage area was only about 0.2 ha, the yearly salt input to the dam from this area was about 3 800 kilograms. Much of this salt accumulated on and around the seep during summer and was washed in to the dam with the first winter rains.

Investigations showed that the seep was caused by the narrowing of the aquifer above a dolerite dyke (see schematic cross-section). Up-slope of the seep the aquifer was six metres thick with a hydraulic conductivity of 3.8 m a day while over the dyke the aquifer was only one metre thick and the conductivity only 0.2 metres a day.

A bore was drilled 18 m to bedrock on the upper edge of the seep, screened over the depth interval of the aquifer and fitted with a jet pump. The initial pumping rate was 90 cubic metres a day. This fell to a steady-state rate of 50 cubic metres a day after about 25 days. Pumping has continued at this rate since February 1984.

Effluent water is disposed of downstream of the dam.

Water levels have been reduced up to 250 m from the bore. The upward flow of water at the seep has ceased and the seep has dried out. In 1985 the water quality in the dam had improved and is now marginal for irrigation.

When the bore was installed, trees were planted around the seep and in an area near the top of the catchment which was thought to be a recharge area for the seep. It is anticipated that after five years these trees will use sufficient water to maintain control of the seep. If this is so, pumping can stop.

The important aspects of this study are:
- Thorough investigation of the site is essential before effective pumped drainage can be installed.
- Pumped drainage can be economical when protecting a valuable resource such as an irrigation dam.
- Pumping can be a short-term engineering solution which is eventually replaced by a permanent biological solution.

Journal of Agriculture, Vol 26, No. 4, 1985