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Seepage interceptor drains for reducing waterlogging and salinity

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Shallow interceptor drains can reduce waterlogging on sloping sites. Such drains will more than pay for themselves from the increased crop yield.

Recent work has shown that these drains also decrease salinity so that they are cost-effective in the long as well as the short term.

Description of the drains

Effective drains for sloping areas with duplex soils (sandy topsoils over clayey subsoils) have the following features:

- A channel in the subsoil clay to intercept all of the water that moves downslope on top of the clay.
- Enough slope to ensure that the intercepted water is carried away and not allowed to seep through the bank or downwards to add to saline groundwaters.
- A safe disposal point for the water, such as a grassed waterway or uneroded creekline.

There are two main types of seepage interceptor drains and one bank used by farmers.

Reverse bank interceptors

Reverse bank interceptors have all of the above features. These interceptors have the spoil from the channel placed on the upslope side (Figure 1) which prevents storm water flows from entering and scouring the drain channel. (See Farmnotes 70/89 and 71/89.)

The drains can be on a high grade (0.6 to 0.8 per cent) which lessens the likelihood that seepage waters will be lost from the channel in permeable soils. This design also lessens the amount of silting in the channel, thereby decreasing the amount of maintenance needed.
Conventional interceptor drains

Conventional interceptor drains have the spoil on the downslope side (Figure 1). Storm water flows into the channels so they must be on a lower slope (0.4 per cent) to avoid scouring. However, the lower slopes do not alter the effectiveness of the drains in most soil types.

This type of drain will need more maintenance to remove silt deposited by rills which start on the upslope side of the channel.

Both reverse and conventional interceptor drains are usually constructed by a grader. However, when subsoil clays are deep they are constructed by bulldozer.

WISALTS interceptor banks

WISALTS interceptor banks (Figure 1) are constructed by a bulldozer and are either level or on an extremely low slope (0.03 per cent). This lack of an adequate slope can worsen salinity (see 'Level banks used to decrease waterlogging can increase salinity' which discusses WISALTS interceptor banks on page 74).

The very steep fall into the channel initiates rills, resulting in erosion and silting of the channel. These deep drains intercept all of the shallow seepage waters on hillslopes. However, their low grades result in the seepage waters being lost, either through the bank or to underlying groundwaters.

Amount of rainfall diverted by drains

The amount of water diverted by reverse and conventional interceptor drains was measured at Narrogin and Mt Barker from 1984 to 1986 and at Cuballing from 1984 to 1985. The amount of water that entered the channel of WISALTS interceptor banks was measured at Narrogin from 1984 to 1986.

In areas receiving between 370 and 470 mm of annual rainfall, the amount of rain that was removed by the drains varied from 1.1 to 7.3 per cent (Table 1). This considerable variation was mainly due to the pattern of rainfall over winter. In the cooler months, more rainfall is interrupted by the drains as crops and pastures use very little water. Drain flow was lower in cropped paddocks because crops use more water than pastures.

At the higher rainfall area at Mt Barker, reverse and conventional interceptor drains removed a high percentage of annual rainfall, particularly in 1984 when the growing season (May to October) rainfall was 13 per cent above average (Table 1).

### Table 1. Percentage of annual rainfall intercepted by drains and banks at Narrogin, Cuballing and Mt Barker. Annual rainfall (mm) is shown in brackets

<table>
<thead>
<tr>
<th>Location</th>
<th>Drain type</th>
<th>1984</th>
<th>1985</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrogin</td>
<td>Reverse</td>
<td>1.3</td>
<td>2.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Narrogin</td>
<td>WISALTS</td>
<td>4.4</td>
<td>6.4</td>
<td>4.8</td>
</tr>
<tr>
<td>Cuballing</td>
<td>Reverse</td>
<td>7.3</td>
<td>3.7</td>
<td>n/d</td>
</tr>
<tr>
<td>Mt Barker</td>
<td>Reverse and</td>
<td>18.8</td>
<td>2.8</td>
<td>n/d</td>
</tr>
<tr>
<td></td>
<td>conventional</td>
<td>(710)</td>
<td>(535)</td>
<td>(548)</td>
</tr>
</tbody>
</table>

n/d = not determined  
* rainfall spread more uniformly over the year
A comparison of the intensity of waterlogging across reverse and conventional interceptor drains at Narrogin and Mt Barker showed that most drains (18 out of 23) had decreased waterlogging downslope of the drain. The mean reduction of waterlogging across the drains (that is, comparing waterlogging upslope with the downslope) was 67 per cent.

As many factors affect the intensity of waterlogging it is possible for the area above the drain to be less prone to waterlogging, thereby masking the effect of the drain. This could happen if there was an area of highly permeable soil above the drain. Under these conditions the drain may appear to have no effect, which is probably why five of the 23 drains did not reduce downslope waterlogging.

The most important criteria used to measure the success of drains is how far upslope and downslope they drain the soil in wet years. Measurements were made of how far drains reduced waterlogging intensity to less than 250 cm.days and 500 cm.days. (The term cm.days is a unit of the SEW30 index, which is a measure of waterlogging intensity. For an explanation of the SEW30 index see 'The causes of waterlogging' on page 58.) An intensity of 500 cm.days is equivalent to water at the soil surface for about 17 days.)

At Narrogin and Mt Barker, seepage interceptor drains had similar upslope and downslope effects in wet years (Table 2). The upslope effect was small, as was expected. The drains reduced waterlogging to less than 500 cm.days between 24 and 28 m downslope of the drains in the wettest year.

This does not mean that drains have to be 30 m apart to be financially beneficial (see later).

### Table 2. Distance (m) downslope and upslope of seepage interceptor drains that waterlogging intensity is reduced to less than 250 and 500 cm.days (SEW30 index)

<table>
<thead>
<tr>
<th>Location (year)</th>
<th>Waterlogging intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>250 cm.days</td>
</tr>
<tr>
<td>Narrogin (1985)</td>
<td>13</td>
</tr>
<tr>
<td>Mt Barker (1984)</td>
<td>14</td>
</tr>
<tr>
<td>Narrogin (1985)</td>
<td>3</td>
</tr>
<tr>
<td>Mt Barker (1984)</td>
<td>3</td>
</tr>
</tbody>
</table>

The high flows were unexpected as the drains were 90 m apart and most of the hillslopes were low (2.5 per cent). However, the subsoil clays were mainly impermeable and the soils had low water storage capacities which resulted in the large drain flows.

Some land holders are concerned that drains will remove water that crops need later in the year.

The drain flow data from Narrogin and Mt Barker show that in dry years drains remove little water.

As rainfall increases the drains remove an increasing percentage of rainfall. This allows crops and pastures to root more deeply and to extract water from deeper in the soil profile.

Some waterlogged areas which receive seepage waters in late spring and summer are valued by farmers for late grazing. In these cases, drainage may not be advantageous.

### Effect of drains on waterlogging

The effect of drains on waterlogging can be assessed in several ways.

As interceptor drains are most effective on their downslope side it would seem sensible to check the level of perched water each side of a drain after a storm. However, as mentioned in 'The causes of waterlogging' on page 58, duplex soils have low capacities to store water. Therefore, immediately after a storm both sides of a drain may be waterlogged.

Once the rain has stopped, the area below the drain will be protected from water flowing in from upslope and this area will recover from waterlogging more rapidly than the area upslope.
At Narrogin, 500 cm.days of waterlogging reduced wheat yields by about 30 per cent whereas at Mt Barker oat yields were little affected by this degree of waterlogging (Figure 2).

As well as reducing the amount of waterlogging, the drains at Mt Barker delayed the onset of waterlogging by three weeks at a time the crops were at an early stage of development and susceptible to waterlogging damage. Waterlogging below the drains also ceased about two weeks earlier than in upslope areas.

Effect of drains on salinity
The longer water is allowed to percolate down old root channels and raise saline groundwater levels, water flows rapidly down these channels and cannot be intercepted by most plant roots. Those drains which quickly remove perched water will lessen recharge and salinity. Most recharge is thought to occur in wet years and it is in these years that the drains remove the most rainfall.

Effect on crop yields
At Mt Barker in 1984, waterlogging intensity had to exceed 1,000 cm.days (equivalent to 33 days at the soil surface) before oats yields declined significantly. For waterlogging in excess of 1,000 cm.days, oat yields declined by about 175 kg/ha for every 100 cm.days of waterlogging (Figure 2).

Oat yields were high where drain spacings were close. Where drains were 50 m apart, yields were twice as high as when they were 150 m apart.

At Narrogin in 1985, wheat yields declined by about 55 kg/ha for every 100 cm.days of waterlogging (equivalent to three days with the water level at the soil surface), despite the year being drier than average.

Cost effectiveness
Whether drains pay for themselves in the long term can be determined for different crop rotations and likelihoods of waterlogging (Salerian and McFarlane 1987).

The costs and benefits of seepage interceptor drains were calculated for Narrogin and Mt Barker for a wheat-pasture-pasture rotation and the return on the investment in drains estimated.

For areas in a paddock with 70 and 90 per cent probabilities of waterlogging (that is, they will waterlog in seven or nine years out of ten on average), drains spaced 60 m apart represented the best investment at Narrogin and Mt Barker. The optimum drain spacing for areas with a 50 per cent probability of waterlogging was 80 m, while areas with only a 30 per cent probability of waterlogging are only just worth draining (on a 100 m spacing).

Investments in drains in the Mt Barker area were particularly rewarding. Drains must be close together (60 m spacing) for the highest returns, despite costing more to build and to maintain, and the removal of more land from production.

As for Narrogin, drains were of marginal value on land which is likely to waterlog for only three years out of ten. However, the more frequent the cropping the more profitable is drainage of waterlogged areas.

Acknowledgements
The financial assistance of the Barley Industry Research Committee of Western Australia is gratefully acknowledged.

Further reading


WISALTS bank affected by silting.

Figure 2. The effect of waterlogging on oat yields at Mt Barker.