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No-tillage sowing decreases water erosion on loamy soils and increases earthworm activity

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Technician Heman Ortiz prepares to weigh the 2 t/ha of silt that has rill-eroded from traditionally-tilled contour bays in the Chapman Valley in 1992.

Bays sown without tillage and using narrow points did not rill-erode.

No-tillage sowing places seed and fertiliser in the soil without loosening all of the topsoil. Soil is cultivated only in the sown rows, leaving the inter-row areas largely undisturbed.

No-tillage sowing reduces both wind and water erosion. Soil structure is generally improved, and pasture regeneration is increased because seed is not buried too deeply for re-establishment.

Two long-term trials were established on loamy soils to determine effects of tillage and cropping on runoff and soil loss. Four, two-hectare contour bays were selected in the Chapman Valley, about 35 km north-east of Geraldton, and eight, one-hectare bays between reverse-bank seepage interceptors at West Dale, about 30 km south-west of Beverley. Earthworm species, numbers and mass were also monitored under the different tillage treatments.

Surface runoff about doubled in the first season of tillage at Chapman, and soil loss increased seventy-fold. At West Dale, there was little surface runoff until soils became saturated in late winter, regardless of tillage treatment.

In the fifth year, the number of earthworms in the no-tillage treatment was three times greater than the number under pasture and twice as great as the number under the minimum tillage treatment.

No-tillage sowing

Tined air seeders can be adapted to sow without tillage by fitting narrow points, provided that the tines have a high enough break-out force to penetrate unthilled soils. Combine seed drills can also be adapted to sow without tillage by removing, raising or tying back cultivating tines.

Commercially-available 50 mm-wide, 'inverted T'-shaped points, 30 mm-wide 'spear' or 12 mm-wide 'knife' points are commonly used for no-tillage sowing in Western Australia. Alternatively, narrow points may be made up in a workshop. Tungsten carbide strips, silver-soldered on the leading edge, generally last longer than wolfram-nickel rod, braised on using an oxy-torch. The wolfram-nickel rod finish can be replaced when worn.
Water erosion

No-tillage sowing reduces runoff. For example, less than 80 per cent of the 254 mm of growing-season rainfall infiltrated a traditionally-tilled sandy loam at Avondale Research Station, near Beverley, in 1983. Less than 87 per cent infiltrated direct-drilled soil sown using a standard combine seed drill, but more than 96 per cent infiltrated soil sown without tillage using a triple-disc drill. Therefore, only 4 per cent of the rainfall was available to run off and erode the no-tillage-sown plots, compared with more than 13 per cent for minimum tillage and 20 per cent for traditional tillage, respectively.

Also, since soil is not loosened by no-tillage sowing it is less susceptible to water erosion.

Traditional tillage makes soil susceptible to erosion of several millimetres of topsoil from sloping loamy soils in a single rainfall event, for example such as in the Northam area and the Chapman Valley near Geraldton in June 1986, and in the Geraldton area and southern regions in May-June 1988.

Soil formation rates are estimated at a mere one millimetre depth per thousand years. Only about 100–400 mm of loamy topsoil overlies a dense sandy-clay subsoil in many Western Australian agricultural areas. Rill erosion on tilled land typically removes topsoil to the depth of cultivation.

Chapman Valley trial

Runoff about doubled under traditional tillage (work-up, work-back and seed), just a matter of weeks after the first tillage operation on the loamy-sand soil for eight years. Before different tillage treatments were applied, runoff and erosion had been similar on all four bays under pasture in the previous year (1991).

Soil loss averaged 3.6 t/ha under traditional tillage from the approximately two-hectare contour bays at Chapman. An average of only 50 kg/ha of soil was eroded after no-tillage sowing on intervening contour bays using 50 mm-wide, ‘inverted T’-shaped points (see Table I).
Runoff occurred because rainfall rates exceeded infiltration rates. The main burst of 52 mm of rain was fairly uniform over six hours. On average, this rainfall intensity happens about every nine years in the area.

Most of the soil loss came from small areas rilled to tillage depth in slight valley depressions between contour grade banks. About 2 t/ha of silt was deposited in contour bank channels below rills.

Only about 200 mm of fertile topsoil overlies a compact sandy clay subsoil at Chapman. Loss of plant nutrients and water holding capacity may result in decreased crop growth and yield in such repeatedly rilled depressions.

Soil did not rill under either no-tillage sowing or pasture during the previous five years of the trial. The suspended soil loss from the nine-year storm under no-tillage sowing in 1992, averaging 0.05 t/ha, is consistent with the estimated soil formation rate of about 15 t/ha (one millimetre depth) per thousand years.

Nitrogen losses from traditionally-tilled bays at Chapman averaged the equivalent of 10 kg/ha of urea, whereas the no-tillage bays averaged only about 1 kg/ha. Ten times as much phosphorus was also lost from the traditionally-tilled bays, though the quantity was relatively small at 1.6 kg/ha. Wheat yields were similar for both treatments.

**West Dale trial**

Runoff, soil and nutrient losses have been measured on the uphill sides of reverse bank seepage interceptors, in addition to seepage over a clayey layer 0.4 m deep at West Dale. Results over seven years show no consistent difference in surface or seepage runoff or erosion from soils sown using the traditional three tillage operations, minimum tillage no-tillage or permanent pasture. Surface runoff at West Dale is mainly from saturated areas in late-winter.

Once surface soils become saturated, the infiltration rate is small and commonly exceeded by rainfall, regardless of the tillage or cropping treatment. No-tillage sowing, therefore, only reduces runoff and soil loss before soils become saturated. Contour, grade or seepage interceptor banks minimise soil loss in both cases by diverting surface runoff, and ensure that sowing is close to the contour.

**Earthworms**

Research throughout Australia has shown that earthworms and termites improve soil aeration and drainage. Both are typically more numerous in no-tilled than traditionally-tilled soils. Earthworms are typically found in moister environments, and termites in drier areas.

No-tillage sowing leaves more organic matter on the surface, resulting in a concentrated and sustained food source for earthworms to increase in size and number.

At Chapman, earthworm numbers in the top 100 mm of soil were similar in the first season after no-tillage and traditional tillage. By the fourth season in a cereal/lupin rotation at West Dale, however, there were four times as many earthworms under no-tillage than traditional tillage treatments – and the

Table 1. Surface runoff and soil loss on loamy-sand soil at Chapman, 8-9 August 1992

<table>
<thead>
<tr>
<th>Rain: 61 mm</th>
<th>No-tillage</th>
<th>Trad. tillage</th>
<th>No-tillage</th>
<th>Trad. tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff (mm)</td>
<td>4.7</td>
<td>12.3</td>
<td>5.1</td>
<td>14.5</td>
</tr>
<tr>
<td>Soil loss (t/ha)</td>
<td>0.002</td>
<td>3.5</td>
<td>0.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>
Aporrectodea trapezoides and Microscolex dubius were the most common earthworms present, and both lay eggs, which may hatch at the beginning of the growing season. Juveniles tended to outnumber adult earthworms in 1993 until September. Adult earthworms may survive the dry summers by burrowing deeper and rolling up into a ball to await the new growing season. Earthworms increase aeration and improve soil structure, as well as providing channels for ponded water infiltration and drainage. Earthworms thriving under minimum and no-tillage sowing may also indicate the presence of other soil fauna, including the microorganisms that inhabit healthy soils.

Conclusion
No-tillage sowing between contour or grade banks reduces water erosion before soils become saturated. After soils become saturated, additional rainfall is available to run off, regardless of tillage treatment. Earthworm numbers and size may increase after several seasons under no-tillage sowing.

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Further reading