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How sustainable is grazing sheep on annual pastures in the woolbelt?

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Soil salinity
The south-western woolbelt has a high risk of salinity. Every year, for many thousands of years, 50 kg of salt has been deposited by rainfall over each hectare of land. Only a fraction of this has been carried back to the sea by the rivers. As a result, between 500 and 3000 t of salt are now stored in the soil profile beneath each hectare of land.

Any water that percolates below the roots of annual pastures causes the groundwater level to rise—by between 25 and 40 cm each year—and this groundwater brings the stored salt to the surface. Mapping the land capabilities of selected areas has shown that between 15 and 20 per cent of the woolbelt could become saline. As the distribution of salt is not even, the percentage will be greater on some farms.

Farmers in 16 woolbelt shires reported that the area affected by salinity increased almost four-fold between 1962 and 1989. In the Kojonup, Boddington, Boyup Brook and Cranbrook Shires the area of salinity increased about three-fold between 1979 and 1989. Of even more concern is that the rate of expansion is continuing to increase.

Low wool prices have reduced the profitability of producing wool from clover-based annual pastures in the south-western woolbelt. The heavy reliance on one commodity is economically unsustainable for many farmers. But we should also consider how ecologically sustainable the practice is.

Shallow-rooted annual pastures contribute to widespread salinity in the area, annual legumes are acidifying the soils and making them water repellent, and bare, detached soils from heavy grazing cause sheet and rill erosion during autumn storms. In addition, stock are degrading remnant vegetation and destroying the soil's structure.

To counteract this degradation, the woolbelt needs more perennial pastures and deep rooting crops, fodder shrubs and trees. Only then can it become sustainable in both economic and conservation terms.

This can be achieved because the area has a reliable rainfall, a long growing season and includes fertile soils, making it suitable for several profitable industries.

Some farmers are already combining cropping, horticulture, sheep and cattle (grazing mixed annual and perennial pastures), timber and wood pulp production. This reduces their reliance on a single market as well as reducing land degradation. In time, intensive farming and diversification may increase the number of people in rural communities in the area.

Natural features of the south-western woolbelt
Farms in the south-west which receive between 500 and 800 mm of annual rainfall cover more than two million hectares. The area extends from Mt Barker in the south to York in the north and from Boyup Brook, Collie and Wandering in the west to Narrogin and Katanning in the east. In the higher rainfall areas the soils are usually gravelly and in medium to lower rainfall areas they are usually shallow sands over clay (duplex soils). Low lying areas often have clayey soils. The woolbelt is hilly and crossed by active streams, unlike the wheatbelt which is usually much flatter.

The predominant industry has been grazing sheep for wool. Less income has been derived from prime lambs, shipping wethers, hay and cereal crops, and cattle. The zone is transitional between the horticultural and cattle industries (intensive mixed farming) to the west and south and the extensive wheatbelt to the east.

How we perceive the area is important. Thinking of it as a 'wet wheatbelt' is to limit its potential compared with thinking of it as an area for 'drier intensive farming'.

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Most of the rivers that drain the south-western woolbelt are too salty for domestic supplies or irrigation because of widespread clearing in the area. Stream salinities are increasing by about 60 mg/L each year. This indicates that the annual pastures are contributing to the rise in groundwater levels and the groundwater is bringing stored salt to the surface (see Table 1).

(Figure 1) and the increase in affected areas is equivalent to losing five 800-ha farms each year. Detailed checks have shown that the saline areas reported in surveys carried out by the Australian Bureau of Statistics underestimate the true extent of salinity. Therefore, satellite images are beginning to be used to estimate salt-affected land.

The Landsat image of the Upper Great Southern on this page has been interpreted to show areas that have little or no plant cover in spring as blue, and partly bare areas and poor pastures as red and orange. Saline areas account for most of the blue and red areas on the image although some smaller areas are roads, towns and bare areas below gravel hills. The coincidence of bare areas and saline creek lines is obvious. Some areas of native vegetation are also becoming affected by rising watertables.

### Stream salinity

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<table>
<thead>
<tr>
<th>River</th>
<th>Salinity (mg/L)</th>
<th>Annual increase in salinity (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murray</td>
<td>2792</td>
<td>39</td>
</tr>
<tr>
<td>Hotham</td>
<td>3711</td>
<td>89</td>
</tr>
<tr>
<td>Williams</td>
<td>2425</td>
<td>95</td>
</tr>
<tr>
<td>Collie</td>
<td>1070</td>
<td>42</td>
</tr>
<tr>
<td>Blackwood</td>
<td>2190</td>
<td>52</td>
</tr>
<tr>
<td>Frankland</td>
<td>2190</td>
<td>44</td>
</tr>
<tr>
<td>Kent</td>
<td>1870</td>
<td>52</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>2321</strong></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>
Soil structure decline
Recent work has shown that the soil structure of loams and clayey soils can be as severely damaged by poor sheep management as by poor cultivation practices. Wet soils pug because the soil surface cannot support animal hooves. The compacted depressions that form in these soils are called "water repellence".

Water repellence
Water repellent soils are caused by an accumulation of waxes around soil particles. The waxes are contained in the outer layer of some plant leaves. In the south-western woolbelt, water repellence is often associated with areas of brown mallet (Eucalyptus astringens), wandoo (E. wandoo) and sandy soils after long periods of subterranean clover or medic pasture.

Water repellency causes poor germination (particularly in years with 'false breaks'), runoff and water erosion. Cropping with cereals reduces water repellence in some soils because the organic matter formed from cereal straw is less repellent than that formed from legumes.

Over summer and autumn, micro-organisms break down organic matter left behind by dead subterranean clover and medic plants and release nitrogen into the soil. The leaching of this nitrogen below the root zone of annual pastures acidifies the soil.

Deep-rooted perennial grasses can take up this nitrogen, may grow after summer rain and do not need to re-establish their roots each year like annuals. Research at Rutherden in Victoria has shown that soils under a 40-year-old perennial pasture were less acidic (0.3 of a pH unit higher) than soils under a subterranean-based pasture.

Many of these factors play a role in the acidification of soils in the south-western woolbelt. The rate of acidification in the woolbelt is expected to be higher than in the lower rainfall wheatbelt, the only region for which rates have been determined so far.

The speed at which soils are acidifying has been determined for sand over clay (duplex) soils and deep yellow sands in a number of wheatbelt areas receiving 350-450 mm average annual rainfall. Acidification has occurred to a depth of 60 cm in the duplex soils and to at least 80 cm in the deep yellow sands.

The rates of acidification can be expressed as the amount of lime required to neutralise the acids. Between 10 and 50 kg lime/ha are needed every year to neutralise all of the acidity produced in the soil profiles. Importantly, continuous subterranean clover pastures and lupin/wheat rotations needed the most lime. Many sites now have levels of acidity that reduce the yield of plants that are sensitive to acidity.

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As well as reducing water quality, salinity is killing much of the riverine vegetation and wetlands. It also threatens the future of intensive industries such as viticulture and horticulture, which rely on high quality water for irrigation.

Soil acidification
Soil acidity is caused by:
- nitrogen (which has been fixed by legumes such as clovers, lupins and medicals) leaching below the root zone,
- adding elemental sulphur or nitrogenous fertilisers such as Agras, sulphate of ammonia, di-ammonium phosphate and urea,
- removing alkaline products such as legume hay and grain, and
- transferring alkaline products from the paddock to sheep camps via waste products.

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Water repellency causes poor germination (particularly in years with 'false breaks'), runoff and water erosion. Cropping with cereals reduces water repellence in some soils because the organic matter formed from cereal straw is less repellent than that formed from legumes.

Water repellency is generally confined to the top 10 cm of soil, which is where pasture seeds germinate. Perennials may be less affected by water repellence because they do not need to germinate each year. The presence of perennials also reduces runoff, increasing infiltration into repellent soils.

Soil structure decline
Recent work has shown that the soil structure of loams and clayey soils can be as severely damaged by poor sheep management as by poor cultivation practices.

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The surfaces of pugged soils dry slowly and this increases the risk of further pugging.

conditions fill with water after rain and because the soil in them has poor infiltration, runoff, inundation and waterlogging can occur.

Poor soil structure reduces plant growth because air cannot enter or leave the soil. In addition, the compacted soil retards root growth. Pugged soils are self-perpetuating because their surfaces dry slowly and this increases the risk of further pugging.

Sheep should be removed or the stocking rate reduced on susceptible soils when they are very wet, have little organic matter or have low root densities. Establishing a dense network of surface roots can help prevent pugging. This is particularly important in the year after cropping when pastures are often poor. Some perennial grasses are able to tolerate waterlogging and can support the weight of stock better than can most annuals.

Farmers with large areas of loamy and clayey soils under annual pastures may find it difficult to find enough pasture on well-drained sites for their stock during winter. On many farms, susceptible soils are not separated by fences from well-drained soils.

Waterlogging

Surveys in the Upper Great Southern have shown that about 60 per cent of soils are affected by waterlogging in years with average rainfall. Summer-dormant and shallow-rooted annual pastures cannot dry out the soil profiles, so this can result in higher levels of waterlogging. For example, in one gravelly soil near Collie, very few annual pasture roots were found more than 70 cm below the surface, whereas young perennial pasture roots extended below 120 cm and roots of cereal crops extended to 150 cm.

The shallow roots of annual pastures result in more recharge into underlying saline groundwaters. Recharge is thought to be particularly high where water ponds for long periods, either on the soil surface (inundation) or on clayey subsoils (waterlogging). Waterlogging kills deep roots, so the plants cannot take up as much water. The water that drains below the shallow roots becomes recharge.

Water erosion

Sheet and rill erosion during intense summer and autumn storms is a feature of some heavily grazed annual pastures. Many drainage lines are becoming gullies and others are laden with sediments.

The main causes of sheet and rill erosion are:

• intense summer and autumn rain,
• the absence of vegetative cover because there are no perennials, few annual grasses and high stocking rates,
• water repellence caused by long periods of subterranean clover-based pastures,
• sheep detaching soil with their hooves and digging for clover seeds,
• high slopes, and
• waterlogging and poor soil structure increasing runoff and erosion during winter storms.

Much of the phosphate responsible for eutrophication in the southern estuaries is attached to soil particles and is the result of erosion during heavy storms. Perennial pastures are recommended to reduce both soil loss and eutrophication.
The future

Although the outlook for sustainable wool production in the south-western woolbelt seems gloomy, agricultural systems that are economically and ecologically sustainable are feasible. The high, reliable rainfall and productive soils makes it possible for a wide range of agricultural enterprises to be considered. Some farmers are already growing high yielding cereal and canola crops, highlighting the inherent productivity of the area.

Increased tree planting (particularly bluegums) and competition for water in the mixed farming areas to the south and west is reducing the area available for horticultural crops, encouraging the move of these industries into the south-western woolbelt. Small areas of high value crops on the most fertile soils can greatly improve the viability of small properties which currently rely on extensive industries.

Already, some farmers are making more profit from their small native flower and horticultural enterprises than from their large sheep flocks. In the short term this should arrest the decline in the rural population and eventually result in more people moving into the south-western woolbelt, revitalising towns and communities.

As an illustration of what the future may hold, one farming family west of Mt Barker has diversified into cereal cropping, cherries and trees for timber and pulp. These alternatives have lowered the groundwater levels and reduced the family's reliance on a single market. Sheep are grazed on phalaris-based pastures, further increasing water use and reducing acidification, water erosion and soil structure decline.

The availability of fresh water has been cited as the main factor limiting the development of some horticultural crops and industries in the area. However, recent drilling has shown that high quality groundwater lies under some valleys. Shallow drains have also been used to supply large quantities of water to irrigation dams. Therefore, with

Decline of remnant vegetation

Stock selectively graze palatable ground plants, prevent regeneration, compact the soil and may ringbark trees. They add nutrients and weed seeds in their excreta and seeds can brush off their bodies. Removing the leaf litter and organic crusts from the soil surface increases soil temperatures and reduces the amount of nitrogen fixed by micro-organisms.

A survey of the effect of stock grazing in the Kent River Water Reserve showed that although sheep were not directly responsible for the rapid death of established trees (unlike cattle), they did reduce the variety of the understorey plants present, destroyed animal and insect habitats, compacted the soil and stopped the natural regeneration of remnant plants. This resulted in the decline and ultimate death of the plants.

The dominant species only regenerated at those times of the year when feed was abundant in cleared areas. Over summer and autumn the re-growth was eaten, particularly by wethers that did not receive supplementary feed over summer.

Understorey plants are thought to intercept and transpire significant amounts of water from native forests.

Recent results from three hill slopes in the Darkan-Boyup Brook area showed that about 5 t/ha/year (or about 0.3 mm/year) of soil has been lost from slopes over the past 20–30 years. It takes about 1000 years to form one millimetre of soil from solid rock, so this rate of loss is equivalent to about 300 years of soil formation being lost each year.

About 30 kg of wool is produced from each hectare in woolbelt shires. Therefore, the weight of soil lost from each hectare is about 170 times more than the weight of wool being produced from that hectare. This comparison highlights the unsustainability of farming systems which cause erosion.

Soil below these lateritic hills is experiencing sheet and rill erosion.
good planning and investigations, water should not be a major limitation to small horticultural areas.

The decline in wool prices is forcing many farmers to reconsider their future sources of income. It could be an opportunity to make a 'virtue out of a necessity' by changing from practices that were not sustainable to those which are more diverse and conserve our natural resources for future farmers.

The attitude that farmers adopt to the change is important. Decisions made on a long term basis are likely to be more satisfying and profitable than those which are expedient while waiting for conditions to return to 'normal'. The challenge is to get financing bodies to consider long term property planning.

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Grazing sheep can quickly denude unfenced bushland of low shrub cover.

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Tony Proffitt, Perry Dolling, Dan Carter and Ken Wallace offered constructive comments on this article. Buddy Wheaton provided the Landsat image. Editorial assistance came from Jo McFarlane.

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**Further reading**


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