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Regenerating the rangelands

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Parts of Western Australia's rangelands have been degraded by inappropriately high stocking rates, often associated with large numbers of native or feral animals, poor seasonal plant growth, or the ravages of cyclones, floods or fire.

Today, most pastoralists are keen to rehabilitate the degradation of the past, as indicated by the proliferation of Land Conservation Districts (LCDs) throughout the pastoral zones.

The first activity of many new LCDs has been to start a regeneration cultivation programme. The results have often been disappointing because of poorer plant growth than anticipated for the money spent.

For best results, rangeland regeneration activities need to be part of the management priorities for the whole station, and be incorporated into the management plan. For example, destocking one part of the station for regeneration purposes could lead to over-stocking and degradation on other areas if stock numbers remained the same.

There is no 'quick fix' to regenerating the rangelands. It may take many years to achieve the desired result.

Stocking rates

A station's first range management priority should be to ensure that all productive land is stocked at an appropriate rate for the particular soil type, the seasonal conditions and the current range condition. Grazing of severely degraded areas should be avoided.

Only then should a pastoralist consider the timing and implementation of a regeneration programme involving costly cultivations and seeding.

Planning for successful regeneration

The successful regeneration of an area of rangeland requires the following:

- Control of all grazing animals.
- Adequate available soil moisture for plant germination and establishment.
- Suitable 'niches' on the soil surface in which seed can lodge, germinate and establish.
- A suitable seeding technique.
- A seed source of rangeland plant species adapted to the area.
- Adequate soil fertility to promote the establishment of plants.
- Adequate finance to carry out the planned regeneration programme, and to maintain fences and cultivations.
- The installation of monitoring sites to assess the rate of plant recovery, and the timing, and intensity of re-grazing the area.

Information should be collected on these requirements during the planning of a regeneration programme so that the most appropriate techniques can be used.
An aerial photograph of extensive pitting and chisel plough cultivation on the Fitzroy River frontage.

Water ponding and cultivation trial site in the Carnarvon area. The tractor indicates the size of these motorgrader-built ponding banks.

Control of grazing animals
Grazing must be controlled to allow established plants to seed, and new plants to establish and produce more seed. Grazing of sheep and cattle can be controlled by fences, the positioning of water-points, or both. Such control is not usually a problem.

Grazing control on an area to be regenerated will be most effective, given present technology, by:

- closing down watering points in and around the regeneration area, and fencing off natural waters; and
- controlling vermin and culling kangaroos as permitted under the quota system.

Control of grazing animals may be all that is needed in some areas, or all that is possible. The key to management for regeneration is to de-stock the affected area during periods of active plant growth and seed production, and to lightly stock the area, when possible, at other times to ensure that ground cover increases year by year. Initially, the ground cover remaining after grazing may be no more than a dead mulch layer, particularly in annual grasslands. However, this mulch layer reduces erosion, traps wind-borne material, conserves soil moisture, reduces soil temperature, and promotes the establishment of perennial plants.

Providing adequate soil moisture
There are many techniques to trap and use rain and run-off water to provide enough soil water for rangeland regeneration. They can be broadly described as: land shaping; cultivation; and soil amelioration.

Land shaping
Land shaping involves building earthworks to divert, harvest or spread run-off water. The type of structure used will depend on the particular regeneration problem. All these forms of structure may need to handle large volumes of run-off water and must be properly planned, surveyed and constructed.

Embankments
Embankments at the heads of gullies are the most common form of water diversion structure used in rangelands. Embankments divert water away from the gully head and 'starve' the gully of the water it needs to cause further elongation. They can divert run-off water to surrounding areas, thereby improving soil moisture status.

On land with an appreciable slope diversion banks must be used with care so as not to cause secondary gullyng. The discharge should be directed into water-spreading structures which release the water as a broad, shallow flow. Water-spreading structures can be used alone to stop the formation of minor channeling of run-off on slight to moderate slopes.

Gully head embankments and water-spreading structures are usually constructed by bulldozers or road graders. They are expensive, and are usually only considered economical where erosion is putting buildings, fences, roads and other infrastructure at risk, or where the earthworks will have a beneficial effect over a large area.
Water ponding

Water harvesting, or 'water ponding', retains rainfall or run-off water behind banks built with a bulldozer, road grader, or tractor-drawn opposed disc machine.

Water ponding can be used on gently sloping land (up to 0.3 to 0.4 per cent slope) to cause the formation of a series of shallow lakes after rain, thus increasing the opportunity for water to infiltrate into the soil. Results from a trial in the Carnarvon area showed that water ponding increased soil moisture after rain by up to 56 per cent.

Individual water ponds cover about 0.5 to 2 ha, depending on ground slope and site. On slopes of less than 0.1 per cent full-circle ponds can be constructed which will contain direct rainfall only; on slopes up to 0.4 per cent open-ended, horseshoe-shaped banks can be built to catch direct rainfall and a proportion of the run-off flowing across the area.

Banks should be surveyed carefully and built to ensure that water is held no deeper than six centimetres in the pond, and that excess water will spill around the end of the banks. Deeper water may cause breaching of the bank.

Water ponding layouts are not suitable for areas subject to deep flooding, unless resources are available to rebuild the banks after flood damage. In areas where intense run-off is expected, water ponding layouts should start as near to the top of the catchment as possible. Layouts should avoid harvesting water from flowlines because this invariably leads to failure of ponding banks.

Water ponding can cause rapid leaching of salts from saline surface soils, thus improving conditions for plant establishment. On soils which generally set hard when dry and 'slake' when wet water ponding tends to increase soil cracking as the soil dries, which aids regeneration. The cracks trap wind-borne seed, and increase infiltration during the next rain.

Cultivation

Cultivation for regeneration purposes increases the availability of soil moisture to plants and provides a suitable bed for seed to lodge and germinate, and for plants to establish. Four main types of implement are used in regeneration work: rippers; ploughs; pitters; and bank builders or 'hillers'.

All machines produce their best results when used on the contour, because this maximises run-off interception and minimises the risk of erosion as a result of the cultivation. At the start of cultivation a few reference contour lines should be surveyed and marked on the ground with the cultivation implement. Subsequent cultivation should run parallel to these contour lines.

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Rippers

Rippers loosen compacted soil and increase its moisture holding capacity to depths of up to 50 cm by breaking and lifting the soil, all of which encourages the survival of establishing perennial plants.

Rippers work best in deep soils free of stones and roots. They should be fitted with shear-pins or stump-jump facilities to protect the implement, tractor, and operator.

There are disadvantages from using rippers: they have the highest horsepower requirement per metre width of cultivation of all cultivation implements; and they may not create particularly favourable niches for seed germination. Recent developments in ripper design have produced rippers requiring less horsepower. Low-draught rippers are a particularly useful primary cultivation tool when followed by pitters or hillers.

Ploughs

Chisel ploughs are usually used for regeneration cultivations. Disc and mouldboard ploughs tend to create a sheared, smeared layer in already compacted soil. Chisel ploughs are particularly effective where a compacted, sealed soil surface crust is the main soil constraint to plant establishment.
This protected river saltbush (Atriplex amnicola) is a prolific seed producer. It was sown with a Mallen Niche Seeder in a water pond in a paddock containing no sheep. The mesh guard protects the plant from grazing kangaroos and goats to ensure it produces seed for further natural regeneration.

Chisel ploughs cultivate to a depth of 15 to 20 cm. They use less horsepower than rippers. They tend to leave micro-ridges and furrows on the soil surface, thus providing a range of niches for seed to lodge and germinate.

Pitters
Pitters can be disc or tined implements. They produce a series of discontinuous basins or pits commonly 15 to 20 cm deep and wide and 0.8 to 1 m. long on the soil surface. Pitter machines used in Western Australia have either four discs or tines, and produce four rows of pits at each pass of the machine.

Pits trap seed and mulch material, and intercept run-off water, making the pitting technique particularly suitable for areas which receive light winter rain. Suitable niches for plant establishment are in the pit and around its lip. However, seed germination and plant establishment can be impaired if water remains in the pit for more than a week.

Disc pitters tend to smear the surface of their pits by the action of the disc, which decreases the infiltration rate of water through the bottom of the pit. These machines are best suited to light textured soils, or where they can be used in combination with rippers working ahead of the discs.

Tine pitters do not suffer so markedly from this problem, and are suited to a wider range of soil types.

Bank builders or 'hillers'
Bank builders or 'hillers' have a pair of inward-facing opposed discs which create an embankment about 30 to 50 cm high and one metre wide. Machine setting and soil conditions govern the size of the bank.

A refinement of this type of machine includes a ripper or rippers positioned ahead of the discs. The ripper(s) loosen the soil, help incorporate the bank with the underlying soil, and improve soil moisture retention in and under the bank.

Banks should always be cultivated along the contour. They are normally cultivated as discontinuous strips overlapping the previous line of cultivation to form a 'brick wall' pattern. This type of cultivation collects run-off water and improves soil moisture levels, particularly when used in conjunction with a chisel plough cultivating parallel to, and immediately upslope of, the banks. On saline soils, salts tend to accumulate in the top of the banks, and the best position for plant establishment appears to be on the sides of the banks where salt levels are minimised.

Mallen Niche Seeder
The Mallen Niche Seeder, developed by the Department of Agriculture, is a refinement of the opposed disc bank builder. It uses a press wheel to create a furrow, into which seed and soil ameliorants are placed, along the top of the bank. The machine was developed to treat salt-affected sites in the State's agricultural areas, but is being tested for its suitability in the rangeland.

Soil amelioration
Certain problem soils may not respond to cultivation and seeding alone. These soils commonly contain high levels of salts, particularly sodium salts. Soils should be tested for salt levels when planning a regeneration programme. The low levels of available soil moisture often associated with saline or sodic soils can be improved with soil ameliorants.

Trials in the West Kimberley showed that perennial grass establishment can be improved through the use of gypsum, grass mulches and polyvinyl alcohol (PVA), a soil stabiliser. The application of gypsum to sodic soil near Carnarvon encouraged perennial shrub establishment in a trial sowing. However, soil ameliorants are expensive. They should only be used for the establishment of small, nucleus areas of parent plants.
Seeding technique

The seeding technique should place the seed at the required rate on that part of the soil surface where it has the best chance of germinating and establishing to a mature plant. This is particularly important when sowing expensive seed.

Precision seeders should be used when sowing uniform, smooth seed. However, most seed sown for regeneration purposes has some characteristic, such as fluffiness or the presence of awns or bracts, which makes it unsuitable for precision seeders. If the seed can be made more uniform and smoother by removing awns and bracts, the cost of this seed treatment will be more than offset by the reduction in the required seed rate, and the improvement in plant establishment.

Irregular shaped seed, or seed which ‘bridges’ in the seeding mechanism, is usually broadcast. The most common broadcaster used in Western Australia’s rangelands is the ‘Monto’-type seeder, which comprises a rotating drum driven by a ground-wheel. The drum contains variable sized openings through which the seed escapes as the implement moves forward, and the drum rotates. Kimberley Seeds Pty Ltd have improved the ‘Monto’ design by catching the seed as it leaves the drum, and directing it to the desired seed niche on the soil. Thus irregular shaped seed can be sown with some precision.

Seeding and cultivation are simultaneous operations, with the seeding mechanism being mounted on the cultivation implement. Cultivation is best when the soil is moist. Seeding will produce the best results soon before the expectation of seasonal rain.

The strategic timing of the regeneration operation is likely to be a trade-off between the ideal timing for cultivation and seeding requirements. Each rangeland environment will have its own best compromise, which will be found by experience. For example, the most effective time for regeneration operations in the southern shrublands appears to be in March and April, before winter rains.

Sources of seed

Generally, perennial species growing naturally in the area will establish the best. Where no suitable species can be found, or its seed readily obtained, several promising species

| Table 1. Species for use in rangeland regeneration in summer rainfall, sub-tropical grasslands |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Species                                         | Light to medium textured soils                  | Heavy textured soils                             |
|                                                 | Saline                                          | Non-saline                                      | Saline                                          | Sodic                                           | Saline                                          | Non-saline                                      |
| Barley Mitchell                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Astrebla pectinata (N)                          |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Bull Mitchell A. squarrosa (N)                  |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Weeping Mitchell A. elymoides (N)               |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Beetle grass Diplachne parviflora (N)           |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Birdwood G. setiger                            |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Gayndah buffel C. ciliaris                      |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| American buffel C. ciliaris                     |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Buffalo clover A. ciliaris                      |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Bundle bundle                                   |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Dichanthium fecundum (N)                        |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Cassia rotundifolia                             |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Cavalcade Centrosema pascoorum                  |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Endeavour stylo                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Stylosanthes guyanensis                        |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Fitzroy shrubby stylo S. scabra                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Seca shrubby stylo S. scabra                    |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Verano stylo S. hamata                          |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Gamba grass Andropogon geyanus                  |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Kapok bush Aerva javanica                       |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Neverfail grass Eragrostis setifolia            |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Woollybuff E. xerophila (N)                     |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Phasey bean                                     |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Macropitium lathyroides                         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Siratro M. atropurpureum                        |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Phoenix cowpea                                  |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Vigna unguiculata (prev. sinensis)              |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Sabi grass Urochloa mozambicensis               |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Sensitive plant Neptunia spp. (N)               |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |

(N): native species
F: some observed flood tolerance
Table 2. Species for use in pastoral rangeland regeneration in arid and semi-arid shrublands, predominantly winter rainfall

<table>
<thead>
<tr>
<th>Species</th>
<th>Light textured soils</th>
<th>Heavy textured soils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saline</td>
<td>Non-saline</td>
</tr>
<tr>
<td>Buffel grass <em>Cenchrus ciliaris</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Birdwood grass <em>C. setiger</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>River saltbush <em>Atriplex amnicola</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Bladder saltbush <em>A. vesicaria</em></td>
<td>*F</td>
<td>*</td>
</tr>
<tr>
<td>Silver saltbush <em>A. banburyana</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Old man saltbush <em>A. nummularia</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Prickly acacia <em>Acacia victoriae</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Cotton bush <em>Ptilotus obovatus</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Gascoyne bluebush <em>Maireana polypterygia</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Spiny bluebush <em>M. aphylla</em></td>
<td>*F</td>
<td>*</td>
</tr>
<tr>
<td>Sago bush <em>M. pyramidata</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Felty bluebush <em>M. tomentosa</em></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Three-winged bluebush <em>M. triptera</em></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

F: some observed flood tolerance

from other areas may need to be tested. In this case, it is unwise to rush into regeneration operations until species have demonstrated an ability to germinate and establish, and to persist through a range of seasons.

Managers should aim for a mixture of species with varying palatabilities. This will ensure that ground cover is maintained in the future. Tables 1 and 2 provide suggestions for species that may be tested in an adaptation screening trial.

Seed may be bought or collected. Purchased seed must be accompanied by a certificate of the seeds’ purity, weed seed content and viability. Seed collected for sale must also be tested and certified. Before ordering seed, seek advice on acceptable germination percentages for the chosen species.

Collectors who harvest seed from rangelands for sale must have a seed collectors license from the Department of Conservation and Land Management. However, lessees do not need a license when collecting seed for on-station use.

Enhancing soil fertility

Fertiliser is seldom applied in rangeland regeneration because of the cost. However, plant establishment on phosphorus deficient soils is improved by the application of superphosphate, as shown by trials with stylos in northern Australia. Fertiliser application for regeneration work is a standard practice only in the rehabilitation of minesites.

Financial considerations

Mechanical regeneration of rangeland is expensive, and is not a ‘quick fix’ solution to rehabilitating degraded country. It may take many years before restocking can start to recoup the initial financial outlay. The major areas of expense are:

- control of grazing animals,
- seed supplies,
- machinery costs,
- labour costs,
- costs of financing the regeneration operation, and
- opportunity cost of not grazing the regeneration area.

Some financial costs are tax deductible. Managers should consult the Department of Agriculture or their LCD for cost-saving ideas for regeneration works.

Monitoring sites

Monitoring sites should be installed on regeneration areas, whether they are cultivated or simply destocked, to record the rate of improvement and whether the chosen method is working.

Department of Agriculture staff are keen to help in the installation of monitoring sites, and can advise on the size and siting of a rangeland monitoring network.

A useful checklist

- Don’t start without a regeneration plan which is incorporated into the whole station management plan.
- Control all grazing animals.
- Collect information on suitable techniques and plant species for your environment.
- Seek advice. Analyse the costs and benefits of different plants. Investigate your eligibility for tax concessions. Consult your LCD, the Department of Agriculture and your accountant. Decide on regeneration techniques.
- Plan a programme in phase with the seasons, which incorporates grazing control, and - if cultivations are to be used - availability of seed and machinery.
- Carry out the programme, and monitor the response.

Further reading

