Rehabilitating degraded rangelands

Strategies for sustainable management of Australia's rangelands, and rehabilitation of degraded areas, need to be based on an appreciation of the complex ecological processes at work in the arid zone

A network of sheep tracks leading to a watering point illustrates the way in which grazing pressure can damage fragile arid ecosystems. Chenopod grasses play an essential role in holding topsoil, nutrients and water in place, but grazing animals break up mounds of soil around saltbush and bluebush shrubs with their hoofs: erosion and degradation occur when this relatively nutrient-rich material is blown away by winds or washed away by heavy rains.

When the first settlers entered the arid lands of the Northern Territory, seeking to establish grazing properties on the basis of explorers' reports, they had a fatally false impression of what level of exploitation the country would support. A succession of good years led the explorers, and the graziers who followed them, to believe that a desert was capable of supporting an intensive pastoral industry.

'What does the opening up and stocking of the immense tract [from the border between South Australia and the Northern Territory to Barrow Creek, some 225 kilometres north of Alice Springs] mean to us?' asked the *Bulletin of the Northern Territory* in 1916. 'At the moderate estimate given for a portion of it, the amount of wool would [have] a money value of £2 million... to say nothing of the annual surplus from 16 million sheep, which may be roughly reckoned at another £1 million.'

After 120-odd years of pastoralism, that 'immense tract' of rangeland now supports only 400 000 cattle in a fair season — about one-quarter of the equivalent in the forecast number of sheep.

The *Bulletin*'s enthusiastic predictions casually ignored the weightily titled *Report of the Commission to Inquire into the State of the Runs Suffering from Drought*, published in South Australia in 1867, which found many properties that had lost all palatable feed and up to 15 centimetres of topsoil only a few years after establishment. The *Report* found that 'the carrying capabilities of the runs within the country indicated have been undoubtedly over-estimated' — in effect, that the supposed drought was in fact the normal condition of the environment.

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The brief flush of growth that follows heavy rain in the arid zone led early graziers to assume the country could support more animals than subsequent experience has shown. As an 1867 report to the South Australian government admitted, 'the carrying capabilities of the runs... have been undoubtedly over-estimated': in effect, what graziers thought was a drought was in fact the environment's normal condition.

For the following 60 years pastoralists and governments alike continued to believe the optimists and to ignore sober advice, with the result that short-lived booms were followed by long-term collapse. Livestock numbers surged, then crashed to a fraction of their peak; rabbit plagues hastened the process and exacerbated the damage wrought by hard-hoofed grazing animals.

Today many pastoralists realise that their properties have severely limited carrying capacities, and that they will lose the profits to be gained from high stocking rates in good years if the environment is degraded during droughts. No longer can it be held that 'the country will always come back', because the pastoralists have seen that damage can be irreversible.

The pastoral community in central Australia is numerically small, but controls vast areas of land. Individual properties are legendarily large, and have in the past been insulated to a great extent from the immediate effects of land degradation: their sheer size meant landholders simply did not have to confront problems as quickly as those in more densely populated areas, such as the rangelands of western New South Wales and Queensland. Now, however, the signs of large-scale degradation in sensitive areas are too graphic to ignore, so industry bodies and government authorities have sought advice on how best to manage the finite rangelands resource.

Looking to balance the needs and interests of pastoralists and the natural environment, Dr Margaret Friedel of the CSIRO Division of Wildlife and Ecology's Centre for Arid Zone Research in Alice Springs has been gathering information from a host of sources (including historical records) that will form the basis of a sustainable approach to the management and rehabilitation of central Australia's rangelands. She is working with Dr David Tongway, who is based at the Division's Canberra headquarters, to develop rangelands-management strategies based primarily on an appreciation of the ecological processes at work in both vegetation and soils.

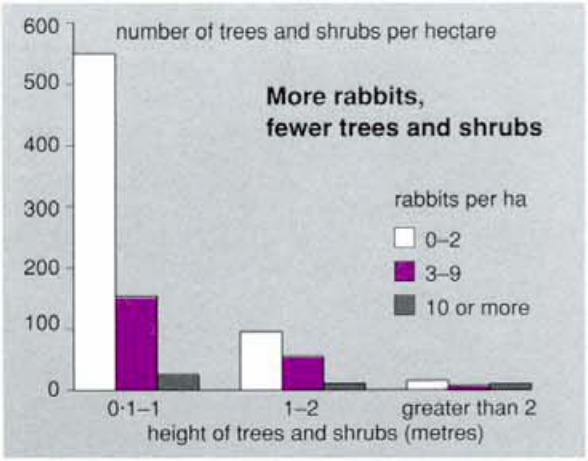
One of the main difficulties in formulating such strategies lies with the episodic nature of the arid zone (see 'Understanding arid Australia' in this issue). Rainfall is central to the arid environment — it is, after all, responsible for the distribution of water and nutrients and hence for the distribution and abundance of plants and animals — but is unpredictable and irregular. Rainfall also affects the environment in other ways: several years of unusually heavy rains tend to be followed by extensive wildfires and, somewhat later, by rabbit plagues and a build-up in the numbers of cattle. Thus a wave of increasing pressure reaches a peak at just that point when the land is again declining into drought and least able to cope with high grazing pressure.

Periods of heavy rainfall can work contrary to the desires of pastoralists, producing more water in the topsoil than grasses can use. With plentiful water, woody seedlings that grasses normally out-compete become established. Then, as the upper soil dries out, these deep-rooted plants tap into subsoil water supplies that are inaccessible to grasses. Without the small, low-intensity fires of Aboriginal 'firestick farming' to burn woody seedlings at this stage, grasses are eventually displaced.

Occasional large wildfires have become more common since the disappearance of the traditional Aboriginal practice of firestick farming, giving fire a bad name as a management tool.

These wholesale changes have had different effects in each of the arid zone's major plant communities. Spinifex grasslands are not favoured by cattle or rabbits and so have sustained little damage. Spinifex can also tolerate high-intensity wildfires and, in most cases, will return to its original composition: lightning ignites it often enough to prevent woody vegetation taking over, and soils remain unaffected.

Chenopod shrublands, characterised by bluebush (*Maireana* spp.) and saltbush (*Atriplex* spp.), support both cattle



Rabbits have a very marked effect on trees and shrubs, as these figures from shrubby woodland on calcareous soils show. Their constant grazing lowers the ability of larger plants to grow further, and, especially in droughts, they substantially reduce the capacity of smaller plants to survive.

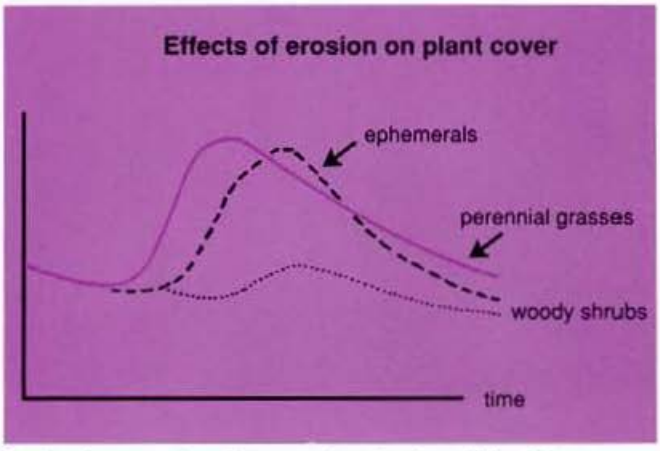
and rabbits, although most feed is provided by the herbs that grow in the shelter these shrubs provide. Cattle and rabbits only eat bluebush and saltbush during droughts; damage to these shrubs occurs most often as a result of damage to the soil around them. Fire is rare in chenopod shrublands and neither type burns easily, so communities of these plants are unlikely to be much altered by wildfires.

Bluebush and saltbush play an essential role in holding topsoil, nutrients and water in place. Natural mounds of sandy soil build up around larger, older plants, protecting the topsoil from wind and helping reduce evaporation: however, cattle moving around the shrublands break up the mounds of soil with their hoofs, and when this relatively nutrient-rich material is blown away or washed away by heavy rains, it takes with it any chance of rapid recovery.

Mulga shrublands grow on a wide variety of soils. Mulga with an understorey of perennial plants is not preferred by either cattle or rabbits, so it shows little signs of degradation from introduced grazers. However, the shrub succumbs rapidly to intense fire and its long-term survival varies according to rainfall. In drier southern areas, fire may stimulate seed germination but irregular follow-up rain (and the possibility of seed stores being depleted by further fires) means degradation is a risk in the long term. By contrast, in wetter northern regions, mulga can become excessively dense without the judicious use of fire. Soil stability varies: mulga shrublands on red earths are more stable than those on coarse or calcareous (limestone) soils.

Low woodlands dominated by a wide variety of acacias are highly preferred by cattle and are very susceptible to grazing damage. In drier southern regions, rabbits infest woodlands growing on calcareous soils and destroy seedling trees and shrubs, so existing trees are relics of pre-rabbit days and will not be replaced as they die. Occasional wildfires also kill trees of all ages, leading to increased soil degradation.

Historically, often unwitting overstocking of sensitive and in many ways fragile environments has led to overgrazing. Dr Friedel points out that this has complex and interconnected effects: however, their complexity can be reduced if the effects of grazing are looked at over space as well as time. She and Dr Tongway tracked changes in bluebush shrublands with a variety of grazing histories — a heavily grazed area close to a watering point, another more than 4 km away and an area that had been fenced off from cattle for 10 years — and correlated vegetation changes with soil fertility and stability.



Erosion has complex effects on plants in the arid landsdcape. Perennial grasses initially do well after erosion has exposed nutrients, but decline gradually over time. The same effect is delayed in ephemeral species, whereas woody shrubs — which play a vital part in maintaining the 'character' of arid Australia — persist for longer periods before entering a slow decline.

Briefly, Dr Friedel and Dr Tongway found that land close to watering points shows clear signs of soil erosion and instability. Pasture species are low in palatability and cover, with especially low cover on eroded surfaces due to soil instability. Bluebush cover is also sparse; old shrubs are dying back because the sandy bands and hummocks they occupied have been trampled by cattle moving in to drink and been washed away.

Further away, at 4-4 km from the watering point, even eroded surfaces carry greater numbers of palatable plants, although cover is still generally poor. Bluebush numbers are much higher, with a mixture of young and old shrubs and apparent recolonisation on eroded surfaces.

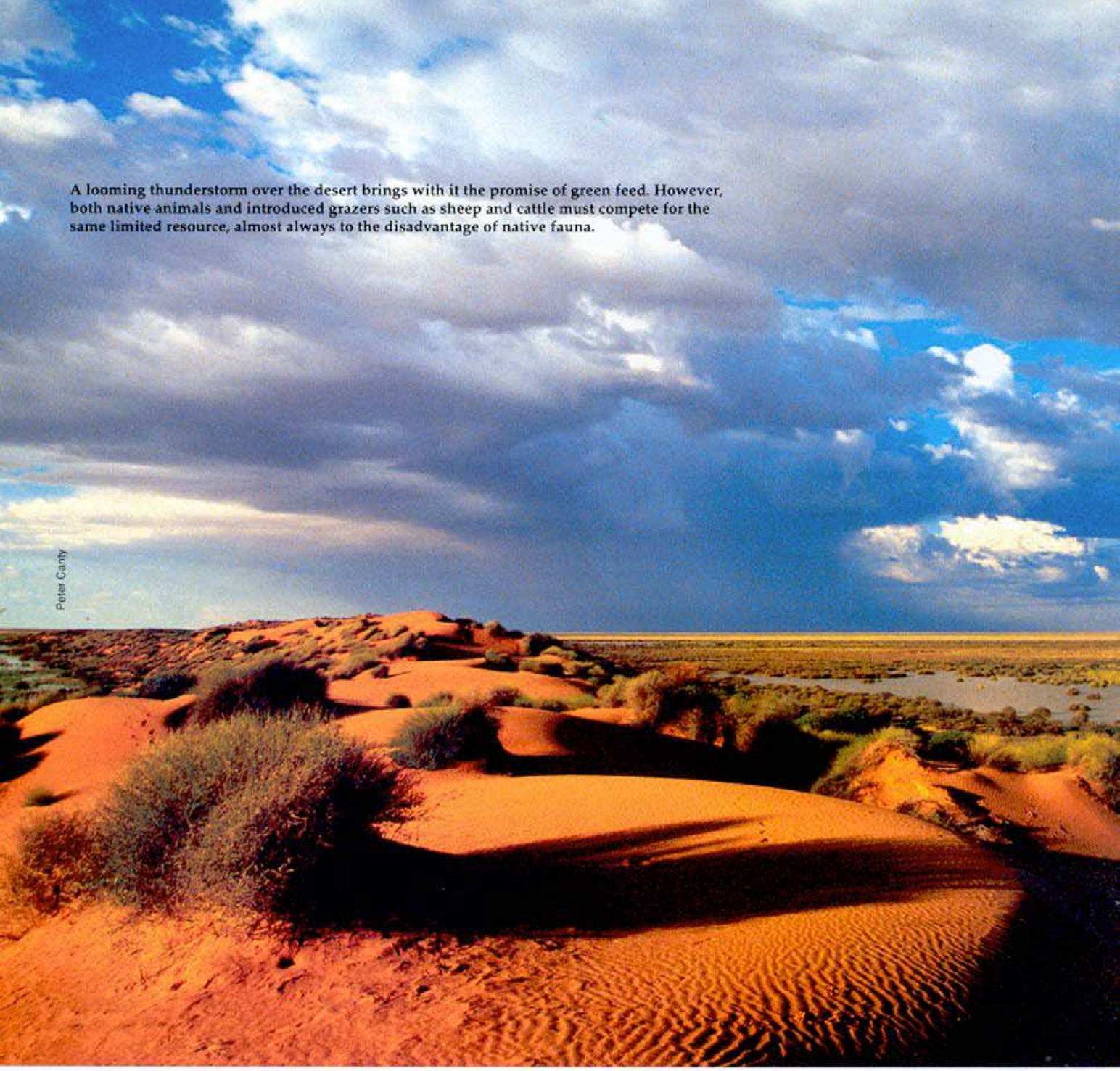
The area that has been fenced off from grazing for a decade shows high palatability in pasture species on the sandier patches: while some recovery of bluebush has occurred on eroded surfaces, it is clear that 10 years of resting have rehabilitated the sandier landscape elements to a much greater degree.

In general, Dr Friedel and Dr Tongway found that the closer one comes to a watering point, the more these landscape elements are broken down and the lower the level of nutrients falls in the critical top few centimetres of soil.

Increased instability leads to a decline in vegetation quantity and quality, eventually reaching a threshold beyond which the potential for recovery is very low. To avoid crossing such a threshold, land managers must learn to recognise key species or attributes of the soil and landscape that act as early warnings.

Dr Freidel and Dr Tongway are currently collecting information that will lead to a descriptive model of how degraded rangeland operates, with a view to formulating sustainable management strategies. Their recommendations will include careful monitoring of vegetation and soils, exclusion of stock from certain areas, control of rabbits and, in some places, mechanical rehabilitation.

The last presents problems in that landholders often want to begin rehabilitation work on the most degraded and unsightly areas, but their attempts at repairing these areas can actually worsen degradation unless they first treat the catchments uphill. Because the plant cover of badly damaged areas has been degraded, the soil itself is also degraded and may not be suitable for, say, constructing ridges to lessen water run-off. The loss of plants means organic matter is no longer being cycled through the soil: and without organic matter, the soil loses the natural cohesiveness that enables it to retain its shape when wet, leaving fine clay particles that create a thin slurry after rain. That slurry infiltrates pores in the soil (many of which are



A looming thunderstorm over the desert brings with it the promise of green feed. However, both native animals and introduced grazers such as sheep and cattle must compete for the same limited resource, almost always to the disadvantage of native fauna.

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themselves the ghosts of plant roots) and fills them rapidly: the rest of the water either runs off, carrying what remains of the soil's minerals and nutrients with it, or it sits on the surface and evaporates before it can penetrate the soil.

A further problem is that rangelands management in Australia is based on models and techniques derived from arid zones in other parts of the world. As the framework developed by Dr Steve Morton and Dr Mark Stafford Smith (see p. 15) shows, this continent's desert regions are unique.

Monitoring techniques used to assess the condition of grazing country are based on the notion of a climax vegetation with which other states can be compared. Such climax communities can be found, for example, in the stable, strongly perennial arid zone of southern Africa; but the climax concept is not relevant to the episodic nature of Australia's arid zone, which has a mixture of ephemerals, annuals and perennials, plus an unpredictable climate.

Central to Dr Friedel's work is the need to come up with ways to help rangelands managers understand the nature of change in the zone. Arid Australia is characterised by a state of punctuated equilibrium in which (to use an astronomical analogy) abrupt 'big bangs' interrupt a steady state. The steady state is one where vegetation undergoes no significant changes in composition over long periods, and 'big bangs' comprise years of heavy rainfall, stimulating major growth and production in both plants and animals. Also important is the concept of thresholds — points in time and space where relatively abrupt changes occur. Dr Friedel's research has looked at two thresholds within central Australia's rangelands: one that separates grassland from woodland, the other stable from degraded soil.

The change from grassland to woody vegetation can occur when the suppression of fire allows woody seedlings to prosper or, in some cases, when grasses that have been overgrazed cannot grow quickly enough to compete for water and nutrients. The second threshold is reached when soil loss outstrips the replenish-

ment of organic matter or mineral nutrients.

By monitoring changes in the composition of plant species over time and space, Dr Friedel is developing a means of detecting thresholds as or before they occur. By modelling the processes at work in Australia's rangelands, and by developing a system of management that provides an early warning of the thresholds between health and degradation, her team will be able to produce a set of tools that will help rangelands managers balance economic and environmental imperatives.

It seems that, far from the 'factory' envisaged by the *Bulletin of the Northern Territory*, rangelands management in central Australia may in future function more efficiently by adapting the Aboriginal philosophy of working with the country rather than trying to change it.

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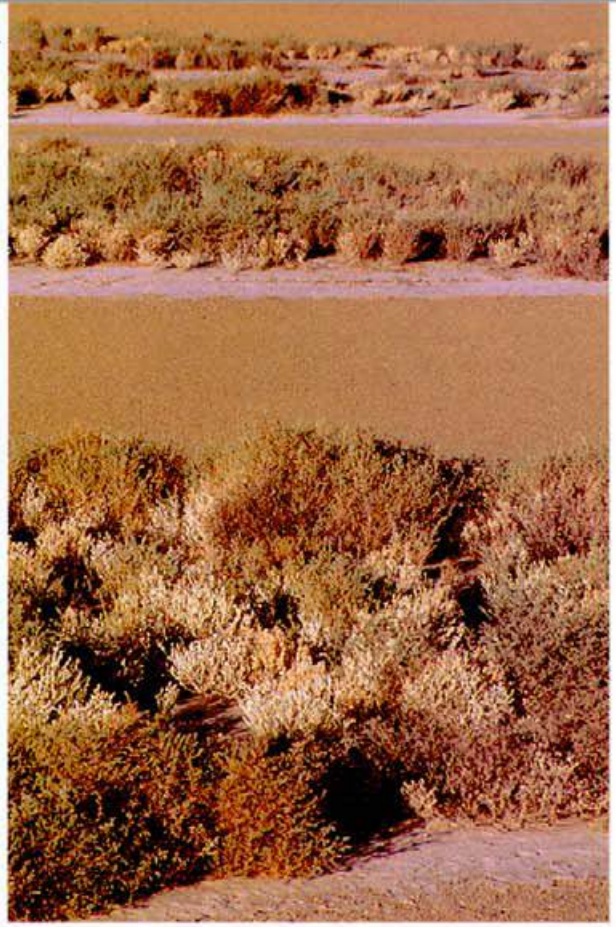

Heavy rainfall can work against pastoralists' wishes, producing more water in the topsoil than grass can use. Woody seedlings — normally out-competed by grasses — become established, then tap into underground water supplies inaccessible to grasses. Without Aboriginal firestick farming's small, low-intensity fires to burn woody seedlings, grasses are eventually displaced.

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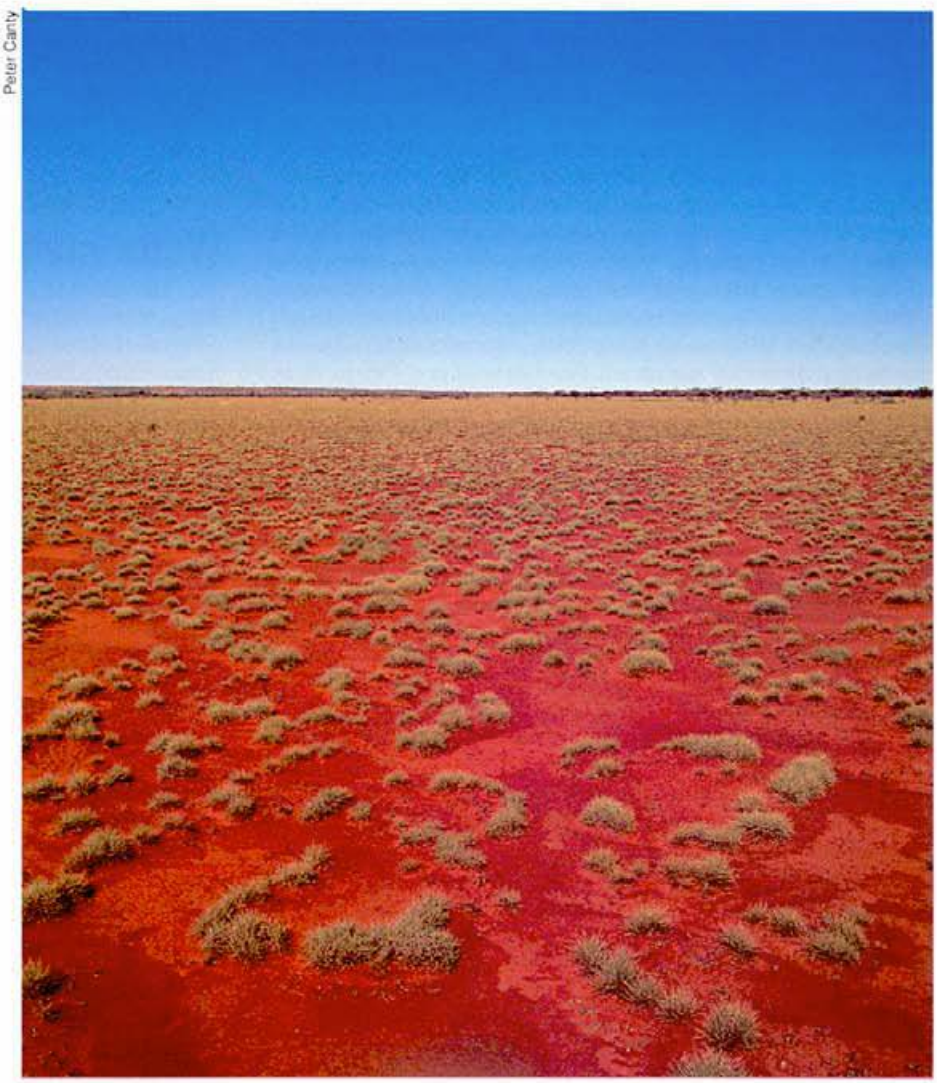

Unlike the chenopod grasslands favoured by cattle (and rabbits), spinifex grasslands have sustained little damage. Spinifex can also tolerate frequent, high-intensity wildfires, so woody vegetation cannot take over and soils remain unaffected.

More about the topic

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