GROWING SOIL CARBON IN AUSTRALIA'S GRAZING RANGELANDS

RANGELAND OR GRASSLAND SOIL CARBON

The rangeland or grasslands in pastoral zones of Australia (excluding national parks, Aboriginal reserves and other government exclusions) comprise some 437 million hectares or 57% of the national land area. These areas are predominantly found in lower rainfall zones. Importantly, in these zones rainfall is usually erratic and/or seasonal. About 95% of Australia has low, erratic or seasonal rainfall characteristics, and much of our grassland is seriously degraded. Soil carbon levels are believed to have dropped considerably due to our use of inappropriate grazing practices.

Because rangeland productivity per hectare is much lower than in more intensive cropping regions, the properties in such areas are usually very large, and they are often great distances from distribution points, farmers cannot economically or practically apply any form of advanced technological solution to the declining grassland production or to deteriorating landscape health. The primary beneficial change that can be effected on a wide scale is a significant change of management to use intentional planned grazing methods. These methods recognise, respect and restore the key features of the global, naturally occurring relationship that exists between soils, plants and grazing animals.

THE NATURAL SOIL > PLANT > GRAZING ANIMAL RELATIONSHIP IN SEASONAL ENVIRONMENTS

For millions of years, natural function in seasonal environments has involved the movement over the landscape of large herds of tightly bunched animals. The Serengeti is a remnant of this natural function. While on other continents many of the grazing animals are ruminants, in his book *The Future Eaters,* Tim Flannery showed that before their extinction there were a number of species of large, non-ruminant animals that played a similar grazing role within Australia's ecology.

In natural environments, tight bunching occurs due to the presence of pack-hunting predators. In the absence of such predators, grazing animals rapidly spread out and halt their constant movement. A large, bunched and constantly moving herd evenly consumes a considerable volume of plant material. In addition the animals deposit concentrated masses of dung and urine onto plants and the soil surface, and they trample large volumes of plant material directly onto the soil surface, thus both covering and protecting it. The immediate positive effect of this treatment is a fouled and unpalatable environment that takes months to recover. During this recovery phase the animals are reluctant to return, and where possible they will deliberately move on to land that has had sufficient time to fully recover. The long-term effect of this complex inter-relationship is healthy, covered soils and abundant, vigorous plant growth.

CURRENT CONVENTIONAL MANAGEMENT PRACTICES ARE OFTEN THE OPPOSITE OF NATURAL FUNCTION

Current management practices within the vast Australian rangelands are often the direct opposite of natural function. Animals are typically spread out in numerous small herds across large areas of land for a long time – usually months or years - as opposed to hours or several days at most as natural function dictates. They are held within fences and so unable to move to fresh ground. The outcome of this management is a significant loss of biodiversity. The symptoms of this biodiversity loss include visibly degrading landscapes characterised by increasingly large areas of bare soil, and gradually declining plant populations and associated animal productivity losses.
Fortunately all these biological symptoms can be reversed, and this reversal requires no new, additional, or as yet untested large-scale technological development. The required management changes and subsequent improvements can begin immediately managers choose to commence intentional planned grazing.

MIMICKING NATURAL PROCESSES

To date in Australia it is estimated that between 8 and 11 million hectares are under some form of management that mimics this natural function. The essence of the technique used is to combine the many small herds into large mobs. These herds are then moved from paddock to paddock in a carefully planned and intentional manner. They remain in each paddock for one to several days at most, and return to that paddock only when the plants are fully recovered from the grazing, which is usually after weeks to months or even longer.

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THE GRASSLANDS EXIST BECAUSE OF PHOTOSYNTHESIS

Plant growth is a biological outcome of a process known as photosynthesis. Briefly, during the photosynthetic process inorganic carbon that is contained within atmospheric carbon dioxide (CO_2) is converted into the various forms of organic carbon compounds that together make up the many large and small plants that sustain all life on earth. This mass of plant and associated plant-consuming organisms is, collectively, biodiversity.

HOW GRASSES GROW

The grasses growing in the rangelands (and elsewhere) all act photo-synthetically just like trees in a forest. They grow as the photosynthetic process proceeds. Specifically looking at grass growth, science shows that when in balance, large leaf masses above ground are always supported by similarly large root masses below the soil surface, and this vegetative material is carbon rich – around 58% elemental carbon. The RH pot in the photo below demonstrates a balanced, healthy plant.

THE *PLANT* > *ANIMAL* RELATIONSHIP

Grass plants grow on a sigmoid basis. If left un-grazed, at some stage in their growth the above-ground or leaf and stem portions of the plant begin to change their cell structure. The cells in the above ground parts of the plant begin to lignify or become 'woody'. If left ungrazed the plant begins to suffer and will eventually die of *'over-rest'*.

On the other hand, plants can also be grazed too early. When a plant is grazed, the natural balance between above ground and below ground structures is disturbed. Just as it is not possible to sustain a large leaf mass upon a small root system, neither is it possible, post-grazing, to sustain a large root system below ground when there remains a smaller post-grazing leaf mass above ground.

Immediately following the act of grazing the plant begins to slough off some of its roots, trying to restore balance to its structure. This material is 58% carbon by weight, the building block of soil carbon. Given time, as post-grazing leaf growth recommences the plant will begin to build new roots to replace those it sloughed off. It does this in order to maintain balance as it recovers from the grazing that was so necessary to sustain its life.

During this period of post-grazing recovery though, the plant is at risk of '*over-grazing'.* If the plant is bitten again before it has fully rebuilt its root system there is a net damage to the plant. If frequent biting is allowed to continue for too long, the plant will die from root destruction directly arising from too frequent grazing. The LH pot in the photo to the right shows a balanced but very unhealthy plant that is close to death, having been 'grazed' too frequently.

THE KEY COMPONENTS OF THE NATURAL *PLANT* > *ANIMAL* RELATIONSHIP:

1. Ungrazed grass plants become increasingly unpalatable and useless to grazing animals
2. In order to avoid death from over-rest, grass plants must be periodically grazed before they begin to lignify
3. If grazed a second time too soon after a previous bite, plants will die of over-grazing

When plants experience periodic, timely grazing and re-grazing both they and the animals that depend on them remain strong, healthy and productive.

THE NATURAL *SOIL* > *PLANT* RELATIONSHIP

Carbon is transferred into the soil as exudates from growing roots, and as decaying carbon rich material whenever roots are sloughed off following periodic grazing as described above. In fact, up to half of the

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carbon captured by the grass plant during photosynthesis can be released into the soil surrounding the plants roots. This carbon is the food that fuels much of the amazing life found in a truly healthy soil.

When the soil surface is correctly managed with intentional planned grazing, much of the carbon that is captured from CO_2 and converted to root material will remain in the soil. Over time and under appropriate management, Soil Carbon levels will increase. When Soil Carbon levels are rising there will be increasing biomass both above and below the soil surface. In addition, as elemental carbon is black in colour, the soil will get darker in colour.

HOW MUCH SOIL CARBON MIGHT ACCUMULATE UNDER APPROPRIATE MANAGEMENT?

Prof. Peter Grace (Queensland University of Technology) has provided the following table which estimates the lpotential national scale of Soil Carbon sequestration in Australia. He has used the SOCRATES model in this estimation. Prof. Grace's numbers are consistent with the calculations of Prof. Keith Paustian from Colorado, who was an IPCC lead author on soils.

Soil carbon change and CO_2 consumption per annum				
Soil type	**Area (M ha)**	**C increase (t/a)**	**Total Mt C**	**Total Mt CO_2**
Calcarosol	42	0.12	5	18
Chromosol	16	0.74	12	43
Dermosol	7	0.74	5	19
Ferrosol	4	1.23	5	18
Kandosol	90	0.51	46	168
Kurosol	3	0.74	2	8
Rudosol	42	0.12	5	18
Sodosol	69	0.74	51	187
Tenosol	89	0.12	11	39
Vertosol	75	1.48	111	407
TOTAL	**437**		**253**	**927**

Estimated areas of each soil type within the >200mm average annual rainfall zone (adjusted for area loss due to National Parks etc) (Grace)

IN SUMMARY

- ✓ Grazing rangelands occupy 57% of the national land area
- ✓ Because of their scale, location and productive capacity it is not financially viable to apply technology based interventions on a wide scale
- ✓ Some 8 to 11 million hectares of Australian rangelands are now managed using the techniques described in this document
- ✓ It is known that Australian soils will sequester CO_2 under appropriately changed management
- ✓ Australia's soils offer a valuable, immediate and lasting contribution to mitigating climate change
- ✓ Appropriate management will likely increase the tonnages able to be sequestered within Australian rangelands beyond those indicated in this paper

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