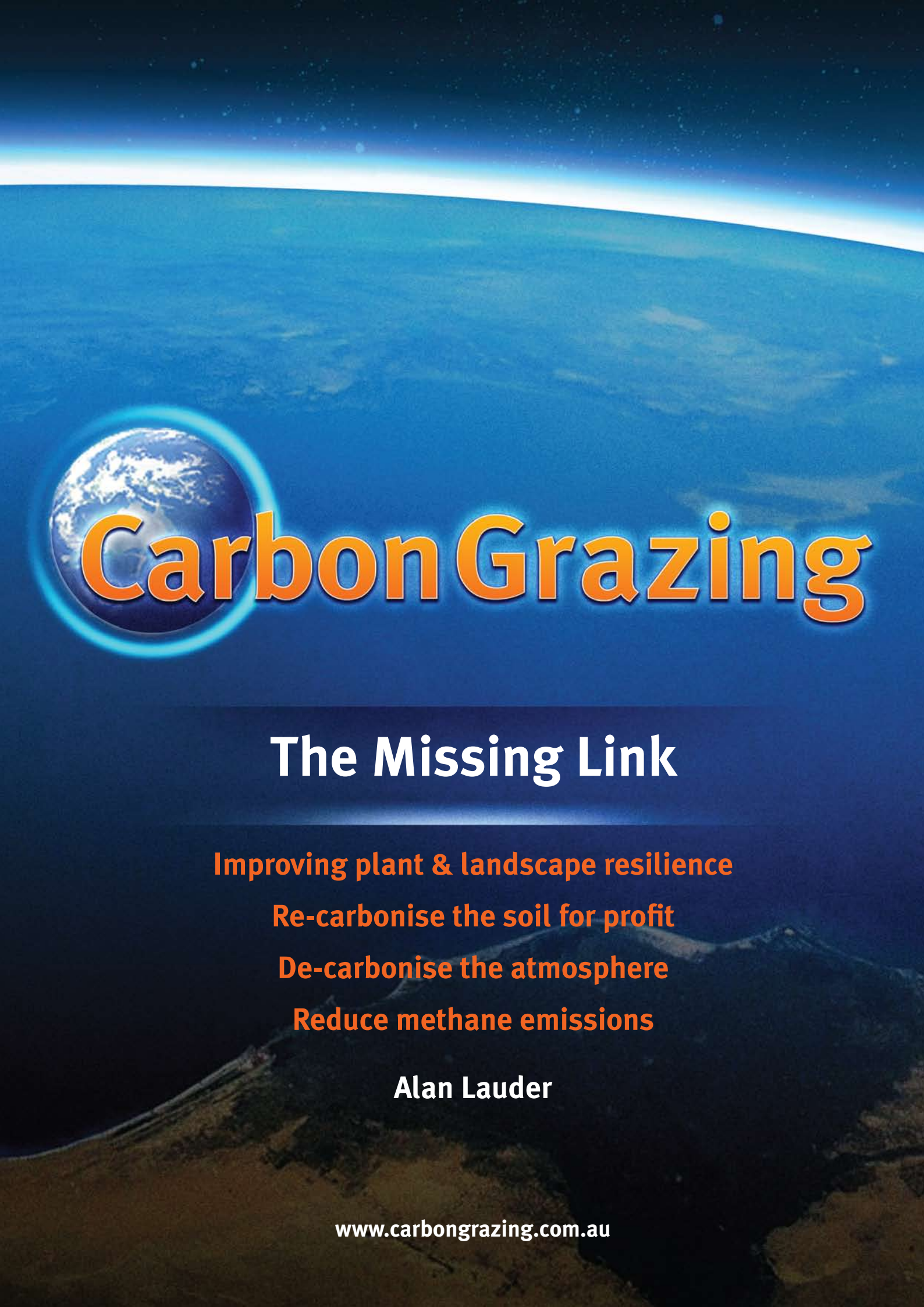

The Missing Link

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CHAPTER 16

THE CARBON GRAZING PRINCIPLE

Recently a friend made an interesting comment. He said that since I started talking about carbon, I have not altered my original approach to land management, nor the actions I suggest should be taken. This is encouraging, because if the message had altered after becoming aware of carbon processes, then it would have meant the original observations were incorrect. The new approach of talking carbon is simply the outcome of discovering the science behind the earlier observations. The observations were made under real-world conditions over many years, which has allowed time for the patterns to emerge.

I raised my friend's comment with a lecturer who had reviewed one of my earlier papers, "Who Does Drought Visit and When" for inclusion in a university course. This paper made no reference to carbon. When I commented to the lecturer that I did not even know there was a carbon cycle when I wrote the paper, he laughed and replied, "You instinctively knew."

THE PRINCIPLE

Sustainable land management is achieved by understanding principles, not implementing recipes. Principles do not change, it is circumstances that change. Principles provide guidance on how to adapt to different circumstances. Engineers are taught principles before they put them into practice in the workplace, so why should graziers be any different? Importantly, principles have to be simple and easy to understand. They are always easier to remember if you understand the "why" as well as the "how".

This book has been slowly building an understanding of the processes behind the Carbon Grazing principle. Now is the time to formalise it into an action plan. **Carbon Grazing is the removal of livestock from pastures for four to six weeks after pasture-growing rain**. This is a general principle, so it is important not to get caught up on the exact time, as there will always be variables such as temperature. Furthermore, as Carbon Grazing is a management procedure, it can be carried out more than once a year, with the emphasis on doing it at least once a year.

Pasture rest is long enough if the perennial plants are able to replenish their energy reserves and annuals succeed in setting enough seed for the future. This need not actually occur during the actual rest period, but it must happen as a result of the rest.

The obvious has to be stated in that livestock do not consume all the plants the first day they are re-introduced to pastures. Therefore, even for the most palatable plants, the actual rest time will always be longer than the exclusion time of animals. The more the most palatable plants have bulked up, the more they take grazing pressure off each other when domestic animals are returned to the pastures.

Carbon Grazing is a general principle and addresses the mechanics of all the processes that contribute to how the landscape operates. **It is about maximising carbon flows when the opportunities arise.** It is about understanding why carbon needs to be allowed to flow through all the components of the landscape both above and below the ground. **It is about managing animals so that they do not excessively limit photosynthesis**. It is also a simple management process that ensures animals do not eliminate the most productive plants in the pasture.

The concept sets out to meet the needs of animals as well as the needs of plants and soil. It is about achieving balance in all the factors of production, as an enterprise will likely fail if any factor of production is not maintained. **The actions required to maintain profit are the same as those required to maintain the environment**.

It is important to realise that the actual rest period does not start until the plants begin to respond to rainfall, not necessarily the day after the rain. This aspect of the principle is consistent with the practical issues of shifting animals.

The principle of Carbon Grazing is "**strategic/tactical rest**" and is based on the premise that nature does not have a predictable pattern. It is all about following the instructions of nature. Strategic rest improves the natural resource base because it coincides with when nature wants to grow plants and regenerate the landscape. This is achieved through all the processes that occur with plant growth. **Stated simply, we must allow nature to transfer carbon from the atmosphere to the landscape according to its time frame**. Carbon Grazing is not based on what might happen, but what is about to happen. Nature's instructions never go astray, as they are always left in the rain gauge.

The logic of "rest immediately after rainfall" is that moisture triggers processes in plants and soil organisms. **Nature has designed the system so that water activates the storage of carbon in the landscape via photosynthesis**. Water also activates the soil biota to release nitrogen, other nutrients, and growth promotants to help plants grow. **Timing** is the important issue because plants are activated by moisture, as are soil microbes. Carbon Grazing is based on the premise that pasture rest is **timing** and not **time**.

Moist soil conditions following rain support the decomposition of organic residues by soil microbes. This is when the soil microbes convert the nitrogen in organic matter to the nitrate form (mineralise it and make it plant available) and also when they produce growth promotants for plants. At the same time, soil microbes are supported in their actions by plants, as this is the time when plants are releasing energy (root exudates) to help them function (consume organic matter). Apart from soil moisture, this is simply the most favourable time for plants to grow, as they are supported by soil organisms. It is essential to utilise nitrogen at the time soil organisms are making it available to plants. As explained earlier in Figures 33 and 34 on page 84, the supply of nitrogen will depend on the quality of plant material returning to the soil. Nitrogen is subject to loss through leaching or ammonification, if not used when it is available (ie can escape the system if not immediately used by plants).

Resting for set periods of time when it is not raining is a consumption issue, not a production or regeneration issue. This must not be confused with strategic / tactical rest. The exception is when a regeneration event has occurred and freshly germinated seedlings need to be protected to allow them to establish. As a separate issue, when landscapes become bare, it may be necessary to remove animals to protect them.

The previous chapter *Pasture rest, is it time or timing?* highlights the importance of allowing carbon to flow from the atmosphere into the landscape after rainfall. On the positive side, it is moisture that instigates photosynthesis. However, on the negative side, it is moisture that can deplete the energy reserves held in the roots of perennial plants. This is because plants will keep trying to grow while there is moisture. If animals are allowed to consume all the above ground growth every time plants emerge from dormancy, then the plants are forced to keep drawing on their energy reserves to promote growth. Given that plants will keep trying to grow when there is moisture and warmth available, it is possible for their energy reserves to be exhausted.

Understanding the principle, "it is the last straw that breaks the camel's back", really applies to plant survival, when energy reserves get too low. This is the point scientist, Dr David Freudenberger makes when he refers to the paradox of average years. Perennial grasses are in and out of dormancy in average years, whereas they do not call on energy reserves during droughts.

One of the core messages of this book is that short-term tactical rest achieves long term outcomes. There is the obvious short-term gain of increased pasture production for animal consumption when plants are allowed to grow. In the short term there is also an increased flow of energy via plant roots to support the regenerative processes occurring in the soil. Taking a longer-term view, the increase in photosynthesis adds to the total carbon pool together with the long-term accrued benefits. Again looking to the longer term, with the next opening rains, the currently rested plants, with higher energy reserves and larger root systems, will respond quicker and more vigorously. Healthy plants can also respond to marginal falls, whereas unhealthy plants in unhealthy soil show little or no response, a very important factor in avoiding drought impacts for longer. If plants are being stressed from ongoing lack of rain, then it is plants which have been allowed to grow after previous rain that are less likely to die, now or in the near future if the season continues to deteriorate.

In summarising the main issues, it is important to separate the two distinct outcomes of rest. The first is stopping the depletion of energy reserves in the roots as perennial plants leave dormancy. The second is allowing all the processes associated with plant growth to occur, which includes the replenishment of energy reserves, and building up an extensive root system. This allows plants to source moisture and nutrients over a larger volume of soil. It also includes allowing soil organisms to restructure the soil so it remains healthy and productive.

In a perfect world, advantage would be taken of every opportunity to rest, but this is not always practical. The focus has to remain on maintaining energy reserves over time, in the same way we must maintain soil condition. It is our overall actions that count. This is why it was stated earlier, "Just as it is important to keep the bank account in the black, so the carbon balance on a property must also be in the black. Farmers can borrow and pay back from this carbon account, but borrowing more than you pay back leads to ecological poverty, followed closely by economic poverty." A single action can be the catalyst to start taking a landscape forward, but it is unlikely a single action would ever bring a healthy landscape to its knees.

In Australia we are never sure whether useful rain is the first of many falls, or an isolated event with no follow-up for a considerable time. This is even more of an issue in the arid rangelands where the cycle of nature is slower. This uncertainty as to what the future holds dictates that a pasture management principle has "**one action plan**" that is consistent with both possibilities. The response to useful rain has to achieve many outcomes including maximising pasture production, pasture and soil regeneration, as well as postponing the return of drought, reducing future plant death and animal stress, and preventing soil deterioration.

How often people choose to apply the principle of Carbon Grazing is determined by the number of suitable events nature supplies, and more importantly, how often producers are in a position to be able to remove livestock from pastures. *Chapter 17: Techniques for spelling looks* at this issue. People in higher rainfall areas are blessed with more opportunities for spelling than those in arid areas. Therefore, producers in lower rainfall areas pay a higher price for missed opportunities.

QUANTIFYING INCREASES IN PRODUCTION AND HENCE CARBON

The South African rangeland scientists I have dealt with are very focused on rest after rainfall. While I was visiting their country they explained that with average pastures, three to eight weeks of rest after rain can see an increase in pasture production of 50-80%. Hence, at the time when pastures are emerging from dormancy, there is the potential for so much lost production.

Yass, NSW, Department of Primary Industry sheep and wool advisor Phil Graham has quantified the lost production due to allowing animals to graze pasture that is trying to grow. In grazing experiments in the spring of both 2001 and 2005, he measured the dry matter production of pastures in a given month.

One side of the paddock was continually grazed; the other left ungrazed. In 2001, by the end of the month the continually grazed pasture had produced 27 kg DM/ha/day; the ungrazed pasture 84 kg DM/ha/day. In 2005, the differences were less acute, but still significant; 45 kg DM/ha/day for the grazed pasture compared with 70 kg DM/ha/day for the ungrazed section.

ANIMALS NEED NOT BE THE VILLAINS

Plants and animals have evolved together and they both rely upon each other. Animals are only the villains when they overwhelm plant growth. Even with plentiful moisture and nutrients, plants can not grow if animals dominate them. On the other hand, plants that are not grazed by animals can actually be at a disadvantage compared to plants that have well managed access to animals. Plants that have evolved to be grazed need animals to eat them to keep them healthy.

Many under-grazed plants become moribund. Under-grazing also reduces carbon flows, because the plants are not photosynthesising to their potential. With uneaten plants, nutrients are tied up in standing feed and are not being recycled by passing through animals, to make them more available for the total plant community.

Humans have a constant desire to modify their environment to suit their needs. A perfect example is building fences to contain animals. Evolution, which perfected the natural system, did not include man-made fences. There is nothing wrong with fences, provided we know where animals should be at any given time. In the past, animals would often have been in the wrong places at times. However, it would not have been ongoing, as is often the case today. Plants can live with animals doing the wrong thing sometimes, but not all of the time. Relationships can handle some bad behaviour, but they become terminal if it is excessive.

If we are going to modify the landscape, then we must keep it functional. This means not managing outside the principles of nature. This issue was raised in the discussion on the three tiers of carbon collection. It was discussed how humans have modified savannah landscapes and simplified them to the two extremes of either annuals only or dense timber.

Energy has already been discussed as one of the main factors driving rural production and landscape health. Carbon Grazing promotes the flow of energy through plants, and in so doing, the energy needs of all other living things. Carbon Grazing is not about plants randomly taking a break from animals. There is neither science nor logic in such action.

THE MECHANICS OF CARBON GRAZING

This section deals with the interaction of animals and plants in the short term. It discusses why a short rest period immediately following growing rain (Carbon Grazing), is able to rest all plant types in a pasture. It is based on an understanding of what animals will select to eat at any given time. The crux of what follows is that unless the animals choose to consume it, a specific plant is being rested, even if animals are on the pasture.

To fully understand why removing animals for four to six weeks rests all pasture species we must focus on the relationship between growth rates and the palatability of the first three plant types (annuals, perennial grasses and perennial edible shrubs). The fourth type, fodder trees, will be left out of this discussion.

Plant Type	Palatabilty	Growth Rate	Drought Resistance
Annuals	**Highest**	**High**	**Low**
Perennial grasses	**Medium**	**Medium**	**Medium**
Perennial edible shrubs	**Lowest**	**Low**	**High**

Figure 36: The different plant types and their characteristics.

The plant types are listed in order of decreasing palatability. In the same order, their growth cycle gets slower. The most palatable annuals grow the fastest, but are also the least drought resistant. At the other extreme, the most drought resistant plants, the perennial edible shrubs, grow the slowest but are the least palatable. For a functional system, it is essential to have these differences between the plant types, as the climate and seasons are so variable.

The characteristics of the different plant types were discussed in *Chapter 14: The four plant types and their role*. To understand the big picture, the plant characteristics need to be considered in conjunction with how animals function. Animals select for green pick (ie protein/nitrogen) and digestibility. Animals also need to ensure that there is enough energy in their diet.

At opening rains, perennial grasses respond the quickest with their succulent shoots readily eaten by stock, as they are available before the germinating annuals. If stock can be removed after such rain for four to six weeks to allow these shoots to grow, then when stock are returned, the choice and bulk of feed is much greater. The grazing pressure on perennial grasses will be much lower if the more palatable annual plants have germinated and established in the absence of stock. If the annuals are well enough established, then even though stock prefer them, they will still succeed in setting enough seed for the future because their growth cycle is faster.

When animals are not removed after regenerating rain, the landscape suffers on two counts. The animals can over-consume the fresh new shoots which the perennial grasses can only produce by drawing on energy reserves. If these new shoots are completely removed, then the perennial grasses have to call on energy reserves again to produce more. As well, stock also pull the more favoured annuals out of the ground before there is time for a good root structure to develop. This means the annuals are not able to produce the bulk of elite fodder of which they are capable. Nor can the annuals prevent over-consumption of new growth on the perennials.

Oats is an annual plant, and croppers never move livestock onto these crops as soon as they germinate. They let the crop build bulk before it is used. Annuals were discussed earlier as the opportunists in the landscape and are important for making the nutrients in the topsoil available to animals.

Implementing tactical resting not only allows the established perennial grasses to regenerate (replenish energy reserves and expand their root system), but also enhances the chances of germinating perennial grasses becoming established. This is because the animals will select the annuals in preference to the perennial seedlings on their own.

In January 1995, when there was perfect germinating rain (five days of rain followed by two days of rain ten days later), I succeeded in re-establishing a perennial pasture from seed by removing sheep for only four weeks. On their return they focused on the abundant annuals and even ignored the perennial seedlings around the watering points. Only mature animals were returned as they had perfected their selection process and were less likely to select the perennial seedlings over the annuals. Local DPI stock inspector, Murray Wingett, documented the outcome on this landscape that was bare from drought prior to the rain.

When the country is bare, we often see animals (especially sheep) limit pasture growth of all species after reasonable rain. With a short-term spell this does not happen if the plants and soil are healthy. Animals set out to consume a given volume of plants, not a certain number of plants. If all the plants have limited growth, then animals can maintain ongoing pressure on the entire pasture. It is important to appreciate that nature does not work in linear mathematics, but rather in an exponential growth mode (multiplier effect). While livestock are eating 1kg of fodder elsewhere, there is a potential for many kg to be created on the spelled country. If the plants can reach the required threshold by achieving the critical mass required, then they can get in front of the animals and continue to build bulk. The extent of this effect is related to the percentage cover of perennial grasses.

All plants have a time when animals decide they are to be selected, and it is at this time that the grazing pressure they are subjected to is determined by their population. The grazing pressure on any plant is determined by the number of similar plants close by and their volume. A plant is protected by how many mates it has and how big they are. This principle applies to the drought resistant plants as well, as there are also times when they are continuously picked on. I have seen hopbush, a woody weed that is not very palatable and only eaten on occasions, thick on one side of the fence while barely existing on the other side of the fence. Where there was plentiful growth, there was a large area of the soil type they grew in, while on the other side there was very little of the required soil type. Here was a low palatability woody weed that could not establish on one side of the fence (small area of suitable soil) because of intermittent excessive grazing pressure, while over the fence it was difficult to ride a bike through it.

Effective previous rest will ensure that the current rest is more successful.

If a good fall of rain is an isolated event, and does not lead to germination, then the annuals will not establish, and the most palatable feed on the return of the livestock will be the perennial grasses.

Following rest, if either the more palatable annuals or perennial grasses are available, then the least palatable, the perennial edible shrubs including saltbush get extended rest. They are free to grow for a considerable time, even although the livestock are on the pastures. They need this extended time to leaf up as they are slower growers. If pastures are well managed, saltbushes will be lightly consumed in good years to supply what is missing in an animal's diet, and this does not stress them. Under these conditions they are given a chance to maintain their energy reserves, and therefore enter dry periods (high grazing pressure) in good health.

I am often asked how to manage saltbush. The management of perennial edible shrubs, if they are part of a pasture, is very simple. Manage the more palatable and productive grasses properly, then excessive grazing pressure is removed from the saltbush. Inferior soils with nutrient deficiencies are prone to overgrazing, under incorrect management. This is because their deep and extensive root system is able to source and concentrate some nutrients that are not readily available to grasses.

At this point, it must be reiterated that the only way to spell a particular plant while animals are on the pasture, is to have more palatable plants available for the animals to access. This requires an understanding of how animals select their diet in your specific area, or region.

Carbon Grazing caters for the needs of animals, plants and the soil. It means not allowing animals to disrupt the logical, practical and highly organised processes which nature has designed.

Carbon Grazing is not cell grazing, but cell grazers achieve Carbon Grazing by their actions. Carbon Grazing presents the evidence to substantiate a number of the outcomes of cell grazing. Carbon Grazing is a general principle applicable to all successful pasture management. It will provide most change with producers who do not want to continue with continuous grazing and also choose not to outlay the capital required for cell grazing.

CARBON GRAZING PROTECTS THE C3 GRASSES

The discussion to this stage has included the first three plant types, as all three remain in some landscapes. The relevant discussion for most producers is based on the first two plant types, the annuals and the perennial grasses.

In furthering the debate on animal selection and the outcomes of rest, it is now time to look at the two different perennial grass groups, the C3 and C4 groups. As discussed earlier, these two groups of perennial grasses have a different attraction for animals due to their different C:N ratio. The rest period required however, to accommodate the differences in the two groups, is still the same. There is a need to allow the more palatable C3 grasses to replenish their energy reserves, with the C4 grasses gaining further rest when animals are re-introduced.

As discussed in the C:N ratio chapter (Chapter 14, starting page 80), the reason animals will select the more palatable C3 plants is in their quest to maximise protein intake. Without rest, the percentage of the C3 plants in the pasture will decline. At an even finer resolution, it can be said that animals will select one C3 over another C3 just the way they pick one C4 in preference to another C4. **These subtleties are not critical to be understood, as the rest period of four to six weeks will guarantee the most palatable plants remain strong, even if the producer is not aware which plants they are. The Carbon Grazing principle provides guidelines on how to manage under all circumstances**.

This last point is reinforced by the South African producer, discussed in the previous chapter, with the pristine pastures, who was getting it right by accident. He just happened to have a management regime where the animals were on saltbush each year when the first storms arrived. Everything else then just fell into place as confirmed by the condition of his pastures. The other person we met who lived not far away, had read widely, yet his pastures were inferior.

Animals are attracted to new growth as it is higher in energy and protein, as well as being more digestible. This compounds the problem of the more palatable C3 grasses being overgrazed. The problem for C3 grasses is that over time they are eaten down, so with rain they will have a higher percentage of new shoots. This means animals are likely to be attracted to them for two reasons, which places more pressure on their energy reserves. The more grasses are grazed; the more likely they are to attract further grazing pressure.

Studies have shown that pastures can remain in good condition with low stocking rates, when continuously grazed. This may be true, but the subtlety is that the most productive plants would be missing. Furthermore, the terms of trade of rural industries determines that consistently low stocking rates are no longer an option.

ONGOING “GREEN PICK”

Carbon Grazing is managing for continuity of “green pick” outside droughts. The availability of green pick over time depends on how healthy the soil and perennial grasses are. Plants must be sufficiently healthy to respond to marginal falls of rain. The successful graziers postpone drought by running out of protein (green pick) later, as their healthy plants have access to moisture for longer. How continuous the green pick will be during dry spells and droughts will depend on the availability of the third and fourth plant types, the saltbushes and the fodder trees.

ENCOURAGING ANIMAL SELECTION

When plants have been permitted to replenish their energy reserves, allowing animals to select the most productive plants available is not an issue. Animals need to be allowed to perform to their genetic potential. Exposing ruminant animals to the highest quality diet possible reduces methane produced per kg of production, as is explained in *Chapter 19: Carbon Grazing reduces methane*. Four to six weeks of rest spells all plant types (the first two types for most producers), then the animals can start with the most palatable and consume the plants in order of preference as the season deteriorates. Having leftover bulk of some of the inferior grasses then becomes low-quality gut fill to go with supplements if the season deteriorates. Having leftover inferior standing feed is good for the landscape as discussed in *Chapter 8: The structural role of carbon*. Inferior plants and plant parts also make the highest contribution to humus. Meat and Livestock Australia, in its EDGE*network*® Grazing Land Management course, suggests that a percentage of the pasture not be consumed and be allocated to the landscape.

Apart from higher production, there is another reason for allowing animals to select their diet. There is additional value in uneaten plants apart from the litter aspect. Uneaten C4 plants help create an environment in which other plants can establish themselves. For example, these C4 grasses contribute to the system via catching nutrients moving across the landscape, ie entrapment. They also lift the wind off the soil surface and shade it, which reduces evaporation and so enhances germination events.

Nature has given us the tools of trade with a complete range in the three plant types which are individually adapted to different circumstances. Fodder trees have a similar role to the perennial edible shrubs. The true meaning of bio-diversity for landscape function is having sufficient plants of each type in the landscape in a balanced mix, not the actual number of different plants. An extensive and diverse population of only annuals does not constitute a healthy and resilient landscape over time.

We must remember that seasons change between summer and winter, and there is often a huge variation in rainfall from one year to the next. The process that nature has designed with the different plant types has the answers for all conditions except for prolonged drought. We must manage pastures to ensure that whatever the circumstances, animals are able to maximise potential production by having access to the most suitable plants.

WHY WE MUST KEEP RESTING

With perennial grasses, the basal area, which is one of the main determinants of soil carbon levels, must be protected for future production and to maintain water infiltration. It is management that changes the basal area of perennial grasses. Plants rely on the number of other similar plants in the landscape to reduce grazing pressure on them. This is why a pasture can deteriorate quickly if the basal area of perennials hits the tipping point.

Critical mass is the issue that took some time for me to really understand in all of its subtleties, be it suddenly increasing plant deaths or the ability of pastures to maintain animals in the shorter term. I remember one day being at the bar swapping lies with a friend and somehow we got onto the topic of; why was it that by putting just 50 extra animals in a paddock that normally ran 700, could get you into so much trouble? The paddock could end up at a very low level of production for an extended time when conditions were below average. However, by keeping the stocking rate at 700, the paddock would have been OK for the same duration and conditions. The extra 50, though, could lead to a large proportion of the original 700 also needing to be removed for an extended period of time.

The relevant principle is that if the landscape is reduced to being bare at any point, then animals can keep it bare. Over time pastures will be eaten and then they will grow again, conditions permitting. However, if at any point in time the critical mass is lost, then all is lost until the next time there is good rain. With the 750 animals, the pasture volume goes up and down fewer times before it arrives at the critical threshold, from which it cannot recover, even if the stock number is reduced back to 700.

Just one short-term rest under these conditions is vital, not so much for the increased pasture production, but for the capacity to move further away from that critical threshold for an extended period of time. While this is an animal production debate about the need to generate profit, it is also about the broader carbon debate and its wider ramifications. This is when some producers lose some of their perennial plants and others do not. These are the circumstances under which some lose part of their carbon pool and others do not.

Subsoils are sometimes dense and difficult to penetrate. Ongoing rest after rainfall is so important, because it keeps soil opened up by ongoing root penetration. As discussed in the soil chapter, carbon compounds do break down over time, so we can not rely for too long on past soil structure. Plants need to keep growing roots to keep helping soil micro-organisms produce glomalin (soil glue), to maintain soil structure. Soil life can not continue to carry out its restructuring role without ongoing energy and a food source from growing plants.

New roots absorb nutrients more rapidly than old roots. Root tips (hair roots) are the active part and this is where the nutrients are taken up. This is another reason why rest is so important after rain to allow grasses to accumulate a root biomass capable of rapid growth.

Seed reserves of desired plants must be maintained, but this will not happen if you do not manage for ongoing rest periods.

With climate change it will be more difficult to establish replacement perennial plants for those that die. It will be just so much more important from here on to prevent the deterioration of plant health. My biggest fear for the future is not so much climate change, but that some people may not appreciate the need to include these new understandings in their management. It is a bit like shifting to a new district and not fully understanding how to manage in changed circumstances. Similarly, in sport, if there is a change of rules, the coach needs to instruct the players to do things differently and also sometimes different things.

WET YEARS ARE OVER EMPHASISED IN RELATION TO REGENERATION

Just as plants create their own environment, so does soil life (biota). It is an ongoing process. **Good management is ongoing, not something that has to be done occasionally**. This is why I feel uncomfortable when wet years are presented as completely responsible for regeneration and undoing droughts.

Regeneration entails preparing the soil so that it is suitable for seed germination and “seedling survival”, not just the establishment phase.

Wet seasons can be misleading in relation to what has really been achieved. The prolific growth just reflects ongoing water availability, and is not a reflection of a more functional landscape. The number of extra plants that remain long-term is the true test of what has been achieved. This is not to discount the extra carbon that is introduced into the soil by the short-term prolific growth.

On a positive note, good seasons fast forward what has already been achieved over time. If the soil has been degraded over a long period and water just runs off, then plants can struggle to establish, even in good seasons. This is documented in Figure 7, page 17.

Past management determines how quickly rain can reverse the effect of drought. To highlight this point, a dead plant at the end of a drought is better for water entry than no plant at all. The wick effect will still occur if there is a dead butt with old roots. The soil structure around where a perennial plant has been will encourage germination from available seed, whereas degraded soil has nothing to offer.

The so called “average years” are really part of the regeneration process, as they give perennial seedlings time to establish before the next drought. The average years, with appropriate management, increase the carbon pool and build resilience into the landscape. My experiences of the holding

paddocks (discussed earlier) that improved without a good season, confirms this is a practical approach rather than an academic one. The regeneration in the South African trial during periods of below average rainfall also demonstrate the same principle.

DROUGHT IN PERSPECTIVE

A healthy soil absorbs and holds rainfall better, so moves into drought later and escapes it sooner. Man-made droughts are unacceptable, while normal drought is part of the natural variability of the Australian climate, for which plants have evolved coping strategies. The landscape does deteriorate during natural drought and carbon levels do fall, but nature reverses this in the better seasons, given correct management. Indeed, in Australia droughts allow nature to kill things and return balance to the landscape. This balance is not achieved if certain plants are not allowed to establish.

Rural producers are really managing carbon, so therefore drought has to be understood in the context of ongoing carbon management and the maintenance of the carbon pool. As stated earlier, just as it is important to keep the bank account in the black, so the carbon balance on the property, must also be in the black. You can borrow from and pay back to this carbon account, but borrowing more than you pay back leads to ecological poverty, followed eventually by economic poverty. We should endeavour to minimise the reduction in the carbon reserves during drought by managing to spend less time in drought. Resting after rain is the payback period to increase the carbon reserves again.

The smart operators think about drought when it rains.

CONCLUSION

Carbon Grazing is all about resting pastures at the right time, which is immediately after rain. With every rest period there is an immediate introduction of carbon into the landscape, especially below the surface. This enhances both short-term and long-term production and keeps the landscape functional. It is the functional landscape which addresses society's environmental expectations on issues including water quality, biodiversity and greenhouse gas, just to name a few.

There are many things which are interacting with each other that are beyond the control of rural producers. What they have to manage is what they can control. Producers do have long-term control over carbon flows, although they may not be able to stop reductions in times of drought. **Ongoing carbon introduction during good and average seasons ensures less carbon is lost during droughts, because the landscape is more resilient**.

Finally, it was The Ecograze Project that documented how rural producers could improve their bottom line, while also maintaining a functional landscape. The project quantified the positives of resting pastures at the right time. They concluded, "Land was maintained in good condition by continuous stocking at 25% utilisation, or early wet season spelling followed by 50% utilisation."

The Ecograze Project highlights what the Australian Wool Board was saying 50 years earlier, when it suggested, "...pastures should not be heavily grazed immediately after heavy summer rains, nor should they be continuously grazed during a long period when conditions are generally dry with an occasional light fall of rain which produces slight growth from the grasses".

We have to focus more on the periods of active growth if we are to reduce the effect of climate change and drought.

"I HAVE FINALLY GOT TO RE-READING CARBON GRAZING. HOW DIFFERENT IT IS ON THE SECOND READ. I AM CAPTIVATED AS YOU REVEAL THE "SECRETS" OF GOOD GRAZING MANAGEMENT."

...SHANE JOYCE, GRAZIER, THEODORE, QUEENSLAND, AUSTRALIA.

"ALAN HAS THE GREAT ABILITY TO THINK ACROSS SCALES FROM THE MOLECULES INVOLVED IN CARBON FIXATION, THE GREEN PICK NEEDED FOR SHEEP AND CATTLE DIGESTION, TO THE GLOBAL CHALLENGE OF CLIMATE CHANGE."

...DR DAVID FREUDENBERGER, FORMER CSIRO SCIENTIST, CANBERRA, AUSTRALIA.