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# Rest after rainfall: the carbon grazing story

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## Abstract

Increasing carbon stocks is dependent upon better management of carbon flows in and slowing flows out. This relies on three strategies: 1) Focusing on the point in time when the bulk of carbon arrives (i.e. the Carbon Grazing principle). 2) Increasing the pathways by which carbon is able to enter the landscape. 3) Improving landscape resilience. How successfully plants introduce carbon into the landscape is determined by animal management. Plants and animals have evolved together and rely on each other. However, if animals dominate plants, then carbon flows and carbon stocks are reduced. In the absence of animals, plants become moribund and therefore have a lower capacity to photosynthesise.

## Introduction

***Focusing on the point in time when the bulk of carbon arrives***

It is nature's design that water activates the storage of carbon in the landscape via photosynthesis. This is why the bulk of the carbon enters the landscape in the short period immediately following rain. This highlights the need to focus our management around this point in time. Nature's instruction is left in the rain gauge.

There is no pattern to when rain arrives, so in other words, when carbon arrives, the message is that pasture rest is timing not time. Basing pasture resting decisions on a certain period of time is no guarantee that carbon will arrive.

Timing has another aspect. Water activates the soil biota to release nitrogen, other nutrients, and growth promotants to assist plants grow. Timing is the important issue, because both plants and soil microbes are activated by moisture. We have to act when they are both working together as a team to promote carbon introduction.

Finally, timing relates to when the soluble carbon from photosynthesis is released for access by the mycorrhizal fungi, located on the roots (root exudation). This allows the fungi to extend out into the soil and source extra nutrients for the plants. It is during this process that some of the longer term carbon compounds are formed.

It has been suggested that with average pastures, 3-8 weeks of rest after rain, can see an increase in pasture production of 50% - 80%. This is reflected in increased root production. It is the management of these short term carbon flows through tactical decisions that determine long term carbon stocks.“Carbon Grazing” is not a new land management system. Members of the scientific community see it as a general principle. “Carbon Grazing” is about maximising carbon flows. The “Carbon Grazing” principle focuses on the outcomes of strategic pasture rest (tactical rest) and is based on the premise that nature does not have a predictable pattern. “Carbon Grazing” is not based on what might happen, but what is about to happen. The basis of the “Carbon Grazing” principle is that pasture rest is timing, not timg. It is 4-6 weeks rest immediately after rain. The period does not commence until the plants actually start growing. Also, it is important not to get caught up on the exact time, as factors like temperature influence the time.“Carbon Grazing” is the window of opportunity too many people miss. The practical aspect of seeing pasture rest as timing, instead of time, is that you only need to find a home for animals for a short period of time. Given saltbush has the ability to withstand dry conditions, saltbush plantations supply one option as an area to place animals after rain. When the landscape is bare and pastures are emerging from dormancy, there is the potential for so much lost production (carbon inputs). This is because animals can stop plants reaching the critical mass they require.

***Increasing the pathways by which carbon is able to enter the landscape.***

There are many different pathways by which carbon enters into the landscape and all must be utilised. Trees are only one pathway. Carbon can be collected at different tiers while utilising water at different depths.

A correct balance of plants leads to ongoing photosynthesis (carbon storage) during the different seasons and varying climatic conditions. However, extreme drought could possibly be an exception to this rule. Maximising landscape carbon and soil carbon is all about trapping sunlight at multiple levels and under different circumstances.

At one extreme, we have the fast growing annuals with shallow roots that utilise the surface moisture in the soil between the perennial grasses. They only grow under good seasonal conditions. Maintaining their seed base is critical for their performance.

In the middle we have the most important group, the perennial grasses. They are responsible for introducing the bulk of the carbon into the soil. Where the perennial grasses differ from annual grasses, is that they can respond to isolated single falls of rain as low as 15 mm. How well they respond is dependent upon previous management.

At the other extreme, are the slow growing perennial edible shrubs (like old man saltbush) that transfer the use of water further into the future. They grow under adverse conditions. They maintain carbon flows over time because of their deep roots sourcing moisture deeper in the landscape, which is not available to the grasses. The carbon in their roots is secure at depth. The shrubs shade the soil and lift the wind to reduce evaporation therefore allowing grasses to introduce more carbon through increased water use efficiency.

Australia has one of the most variable climates on earth, which appears to be becoming even more variable. Therefore the focus must be on increasing the percentage of perennials, as they are the best equipped to turn water into carbon compounds under Australian conditions.

***Improving landscape resilience***

Carbon takes many different forms after it moves from the atmosphere to the landscape via photosynthesis. These different carbon compounds add to the resilience of the landscape. The resilience of the landscape relies on the resilience of both plants and the soil. Allowing carbon to flow into plants increases their resilience by increasing internal energy reserves for them to call upon. Carbon flows have the added advantage of producing a more extensive and deeper root system to allow plants to source water and nutrients. Plant resilience is achieved by resting pastures immediately after rain.

Allowing plants to grow after rain and supply carbon compounds to the soil, increases soil resilience by allowing the soil biota to reproduce and restructure the soil. Soils with a better carbon supply have improved water infiltration, increased water storage capacity and are more fertile. Resilient landscapes reduce evaporation through more shading and lifting the wind. This is achieved by higher ground cover, which is influenced by short term tactical decisions to rest pastures after rain. Adding the taller perennial edible shrubs gives more permanency to ground cover. Resilient landscapes have so much more to offer because they are cooler. In summary, resilient landscapes are more efficient at utilising rainfall to increase carbon stocks via increased carbon inflows i.e. water use efficiency. If we are going to build carbon reserves, then it is critical to ensure that water leaves via transpiration instead of evaporation or runoff. The water must be used to produce carbon compounds.

On the carbon loss side of the equation, resilient landscapes have root matter at greater depth, which is due to better root growth and plant selection. Carbon loss is reduced with the lower oxygen levels at depth. Carbon losses are also marginally reduced through lower temperatures at depth.

While there is moisture in the soil keeping soil microbes active and consuming some of the existing carbon stocks, it is important that plants are utilising moisture in the same soil. This ensures carbon flows in while there are flows out.

Plants not rested after rain cannot extend their roots into the same percentage of the soil. This results in sections of the landscape, where water remains available to the soil microbes for longer, enabling them to keep consuming organic carbon while it is not being replaced.

In dry times when carbon stocks are traditionally depleted, resilient landscapes have lower losses. This is because resilient landscapes can photosynthesise with isolated marginal falls of rain, while fragile landscapes remain dormant and the water only activates the soil microbes to consume organic carbon.

Soil microbes prefer the more palatable initial carbon compounds introduced by plants. If pasture management restricts the flow of these initial compounds, (which microbes consume and modify into longer term compounds), they are then forced to consume the existing longer term carbon stocks.

Resilient landscapes attract higher rainfall (especially in dry years) as they have different energy patterns and often have more moisture to offer weather systems. The same principles apply to the pattern of storms often following where the first one occurred.

## Conclusion

It is resilient landscapes, with ongoing pasture rest after rain, which achieve the highest long term carbon stocks. Just as money makes money, so carbon makes carbon, given the correct management. Resilient systems spend less time in drought hence spend less time when carbon balances are reducing. It is likely that resilient landscapes have a shorter period between the time that grasses hit wilting point and when the bulk of soil microbes go into dormancy. This would reduce the time when carbon is flowing out without any replacement. Water use efficiency is the cornerstone of maximising carbon inflows. Water use efficiency relies on the health of both plants and soil as well as the mix of plants. It is the management of short term flows through tactical decision making that influences the long term carbon stocks. Summing up, with carbon, once you understand the flows, you see the dynamics of the whole landscape and how it functions.

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