The Carbon Flows Concept and Carbon Grazing ©

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PURPOSE OF THIS PAPER


It is advisable to read this file prior to reading the book, as the book will be of more value if these insights are in the reader’s mind at the outset.

Explanatory note

The principle of Carbon Grazing is spelling pastures for a period of four to six weeks after grass-growing rain to ensure that carbon flows are maximised. Pasture rest is long enough when sufficient carbon has flowed to all parts of the landscape it needs to, including below ground. This approach will maximise animal production and ensure ongoing resilience of the production base. It will also improve environmental outcomes for the broader community.

THE ESSENTIALS

Carbon flows and stocks

To understand the difference between the concept of carbon flows and carbon stocks, any carbon that is flowing through the paddock at the time of measurement, is recorded as a stock. Carbon flows are ongoing while carbon stocks are a measurement at one point in time. Carbon stocks at the time of measurement are called short term (labile), medium term and long term. Carbon flows involve virtually no long term carbon. Long term carbon does flow but at an incredibly slow speed, which is why it has little involvement in carbon flows.
A grazing paddock is a dynamic system, not a static one. To understand how a paddock functions, it is important to understand the role of the element carbon as it flows through different paths after it enters the paddock.

Carbon is the main building block of all life and is a carrier of energy through a natural system. As it moves, carbon takes different forms – such as animals, plant leaves, plant roots, soil life, soil organic matter. These different forms contain carbon in different chemical combinations and their individual carbon-containing molecules flow through the system at different rates. Carbon keeps flowing above ground as well as below ground, including through commercial livestock.

Carbon compounds in a paddock can be loosely classified into short-term (labile), medium-term and long-term, though there is a continuum. The dynamic nature of carbon is not revealed by spot measurements taken at a point in time, commonly referred to as ‘stocks’. Considering soil carbon, the technique used for measurement uses a 2mm sieve that removes about a third of grass roots which are labile carbon. Root exudate (soluble carbon), the fastest flowing carbon, is outside the measurement process.

The measure of long-term carbon is reliable as it is slow-moving. However with the faster moving short-term carbon, the circumstances under which it is measured matter. It is very easy to catch a spike that is not representative.

Short-term carbon, which accounts for the bulk of flowing carbon in a paddock, moves through the landscape by ongoing interchange between plants, animals and soil. This exchange powers the health of the paddock and pastoral productivity in particular. The volume of flowing carbon in a paddock reflects recent land management decisions. On the other hand, the level of long-term carbon is a consequence of past decision-making. Long-term soil carbon is important for paddock health, even though it moves at an extremely slow speed and its level is slow to change. However, it is not responsible for short-term changes in paddock health or productivity. These short-term improvements are driven by the short-term carbon introduced in the first phase of carbon flows, being when plants introduce carbon from the atmosphere to the paddock via photosynthesis. Also, the carbon in long-term soil carbon has to start the journey as short-term carbon in the first phase of carbon flows.

Long-term soil carbon has become prominent in public debate because of climate change policy and carbon trading. Payments to landholders in the form of carbon credit schemes for storing carbon apply only to long-term forms of carbon, because carbon that flows quickly cannot be secured. However, payments in the form of stewardship incentives can be justified for management changes that increase the flow of carbon and so improve paddock and catchment condition. The two purposes are distinct and different metrics are needed to assess them.

The concept of carbon flows highlights the ongoing nature of carbon transfers; whereas the alternative concept of carbon stocks (a measurement at one point in time) is a static one and says little about what is driving changes in the health of the landscape or the relative significance of past and current management decisions.

An understanding of carbon flows leads into recognition of the importance of timing the removal of livestock when managing a pastoral property. Removing grazing animals from paddocks for a short period after rain, to ensure carbon flows are not reduced, was central to the book Carbon Grazing. The book made the proposal that pasture rest is TIMING, not TIME, because it is rainfall events that are the trigger for the decision to
remove animals. This update explains why timing matters, in terms of the dynamics of carbon.

Thinking dynamic ‘carbon flows’ rather than static ‘carbon stocks’ leads to a better understanding of how a paddock functions and needs to be managed.

There is a reason why a paddock is more productive when carbon moves more quickly. In the case of soil, it is simply because everything that is joined to carbon as it moves through the soil – think energy and nutrients – becomes available to plants sooner. When pasture carbon moves through sheep and cattle faster, they get to market sooner.

**Without carbon flows, paddocks would be bare and lifeless**

Both rural profits and catchment protection are directly linked to management of carbon flows.

Many landholders would not link the different outcomes on each side of the fence in the photograph following to different carbon management or more precisely, different management of carbon flows. The right hand side of the fence is a grazing paddock, not a farming paddock. The outcome reflects more than just soil structure. Pastoralists understand that at a paddock level, they must prevent water from accumulating volume and gathering speed. Fast-moving water collects topsoil and gouges out gullies on the way to the Great Barrier Reef.

Producers like to be shown things to which they can relate rather than be regaled with scientific information. Also, information has to be seen as relevant to what they do before they will show any interest. People are more likely to change their decision-making if they understand the reasoning.

Paddock resilience is a combination of plant resilience and soil resilience. Both are directly linked to management of carbon flows. Plants fail first and then the soil fails. Put another way, plant resilience declines first then soil resilience declines.

It is paddock resilience that enables one producer to get a response from a marginal fall of rain in a dry year and another not. If ever the pastoralist needs something to grow, it is in marginal years.
Extension needs the unifying concept of carbon flows

Given that the goal of extension is to achieve change on the ground, and given that management practices reflect the manager’s view of the world, achieving change relies on helping people see the world differently. My aim is to present new information to producers so that they see their paddocks differently.

My message focuses on the concept of ‘carbon flows’. This is different from discussing the carbon cycle diagram. The carbon cycle diagram commonly seen in textbooks is one-dimensional. It goes no further than saying that carbon cycles between different pools. This leads to the question, has extension to the grazing industry focused on the wrong aspect of carbon from a management perspective?

The carbon flows concept discusses the role of carbon as it keeps moving through the paddock, above and below ground, including through livestock. The concept explains what carbon does as it moves and the processes it activates, before returning to the atmosphere. It highlights that carbon is the organiser as it flows at different speeds through the landscape. The concept enables producers to focus on what matters most to their productivity.

Management practices increase or decrease the flow of carbon through paddocks. The concept of carbon flows identifies feedback loops, such as why the level of current flows is influenced by the management of previous flows. With carbon flows, once one visualises the flows, the dynamics of the whole system and how it functions becomes clearer.

A CSIRO scientist commented to me, that as better information is made available to producers, best management practice guidance materials may be amended to alter the rankings they assign to properties in the future. What is currently assessed as A grade country might be assessed as B grade, if there is actually more potential in pastures than we currently realise.

Grazing best management practice (BMP) is simply a benchmarking tool and not an educator. However, the outcomes of the BMP process are limited by the content of the guidance materials that graziers utilise. There is anecdotal evidence that many scientist-extension officers while knowledgeable about soil profiles, water contents, root growth, stocking rates and grass cover, conceptualise these as separate processes and are not necessarily conscious of the dynamic flows by which carbon drives the entire pastoral landscape.

At the Grazing BMP presentation mentioned above, I made the case for a new knowledge resource based on the carbon flows concept that Grazing BMP and other programs could call up.

To demonstrate that this is a good idea, I share the main points of a presentation by cattle producer, Stephen Martin at a government-convened workshop at the Ecosciences Precinct in 2014. Steve’s family has been on the same property at Gladstone for generations. He discovered that the potential of the property was greater than previous generations thought. By applying management practices focused on increasing carbon flows, he achieved the following results (backed up by photographs):

1. Increased carrying capacity (previously 130, subsequently the equivalent of 190 adult cattle). That is a 46% increase.
2. Improved calving rates – previously 40-50%, subsequently around 80%.
3. Quicker pasture recovery following dry periods.
4. Faster throughput of stock to market.
5. Much less water running off his paddocks.
6. Improved soil moisture.

“In November 2012 we had about 30mm of rain spread over three days. I sampled the top 100mm of soil on both sides of a boundary fence. The samples were taken after three fine days. I made no attempt to remove any root matter but did skim the grass off the surface to prepare the site prior to sampling.

The neighbour’s side had 13.6% moisture whilst my side had 17.6% moisture. I have assumed a value of 1.6t/m^2 for the density of the topsoil. This means that there is an extra 6.4 litres of water per square metre in the top 100mm in my paddock”.

He said, “The light bulb moment for me was visualising the flow of carbon through the landscape.” Apart from improved financial outcomes, Steve has confirmed that he now has better control of his destiny and is not suffering stress with dry spells as before.

**The term carbon is under-used in extension**

Much of the landscape carbon on which producers rely is not referred to in a carbon context. A good example is ground cover. We rarely talk about it in terms of being carbon-based. Institutional extension services focus on stocking rate, pasture utilisation rates and maintenance of a minimum level of ground cover. This is 1980s science.

A typical industry extension program discusses ground cover in terms of not consuming too much (important), but does not discuss land management in terms of increasing carbon flows to provide more ground cover. Level of consumption is the second decision producers need to make, with the first one being management of carbon flows to increase ground cover prior to consumption. *Over-consuming flows after they have arrived is very different from reducing the flow of carbon in the first place, and is by far the lesser of the two transgressions.* Carbon flows end up above and below ground, while animal consumption involves only what ends up above ground.

We are too focused on just soil carbon in extension. Carbon seems to be discussed as carbon only when it is below ground. The only time we seem to think about carbon being above ground is in trees, but this is only because trees are long term carbon. Grass is short-term carbon.

Because carbon is the organiser as it flows through the paddock, explaining the path of carbon above and below ground helps producers to better understand how the whole paddock functions. It gives them a better understanding of how everything fits together. Decision-making is successful only if one has a big picture understanding. Big picture people think about how the different cycles work together. They don’t think of them as working in isolation. The carbon : nitrogen ratio is a good example. This ratio determines the outcomes of many processes.

Producers need to be able to mentally follow the path of carbon and have an understanding of what it does. This makes it easier for them to understand how the landscape functions.

**Proposed carbon flows module**

Current extension kits should be augmented with an introductory component to prepare a producer’s mind for better understanding subsequent advisory materials. It would take a systems approach and explain the underlying scientific principles of pasture management and animal production. This module would supply the ‘big-picture’ canvas a
producer needs in order to view their system differently. The module would not require any rewriting of current resources.

The module would introduce producers to the carbon flows concept. It would shift producers from a static perception of carbon, to appreciating that carbon is always moving and at different speeds, as it drives landscape function. It would advise on how to increase the volume of carbon flowing through the landscape and its speed. It would enhance environmental outcomes such as Reef protection and greenhouse reduction, including methane reduction per kilogram of livestock production. It would support Direct Action, because long-term carbon has to start the journey as carbon flows.

A possible title for the module would be: “Better managing carbon flows for increased profits and better environmental outcomes”.

**Carbon flows in action**

The following images demonstrate how increasing the amount of carbon moving through a paddock turned a long-lasting claypan into productive country. Note I used the word ‘moving’, not ‘sequestering’.

This image demonstrates the importance of restarting carbon flows. Functional landscapes rely on carbon flowing through them. This is a long-lasting claypan, where the soil component of resilience had failed years ago. This is planting a source of carbon flows, when nothing could establish naturally from seed to do the job.

The left-hand image is Old Man Saltbush 12 months after it was planted. The second image is another year later. Sheep are responsible for the lack of leaves on the saltbush as they were chasing protein. *The saltbush is reducing the amount of methane produced per kg of production, but that is another story.*

In this image, you will notice the effects of carbon flowing into the area around the shrubs. In other words, the landscape is becoming more resilient. The carbon flows introduced by the planted saltbush led to increased life within the soil and hence improvement of the soil. As the soil improved, grass was able to germinate and further expand the area through which carbon is flowing.

All this happened over a two year period at Yelarbon, Queensland, when rainfall was well below average.
This photograph was taken three years after the saltbush was planted. The clover is now adding nitrogen to the system as it further contributes to flows.

This photograph was taken five years after the saltbush was planted.

After carbon started flowing again, energy, nutrients and water all followed. *All producers appreciate the importance of energy, nutrients and water.* The concept of carbon flows links these processes, so putting carbon in a new perspective. Plants are now growing, which is introducing energy. The build-up of organic matter in the soil is increasing nutrient supply. Looking at the prolific grass, water is obviously penetrating now, unlike previously.
This photo was taken immediately after a few mm of rain. The connection between management of carbon flows and retention of sediment and nutrients within the paddocks and off the Reef is plain.

The wet decade of the 1970s couldn’t repair this claypan. Nor the big rains in the early 1990s. However, during a period of below average rainfall, carbon flows regenerated the claypan.

Many producers assume too close an association between rainfall, rural production and healthy landscapes. This association is valid only up to a point. Producers have no control over how much rain arrives but they do control the level of carbon flows generated by what rain does arrive. It is the level of flows that determine rural production and landscape health.

Producers are encouraged to think in reverse to appreciate how management that reduces the flow of carbon into paddocks also reduces production and increases degradation. As paddocks become less resilient, droughts turn up sooner. This paddock was in a state of drought during normal years.

Think of carbon as the organiser. It organises so many processes as it flows through paddocks. It is by following the path of carbon that producers gain a better understanding of how everything fits together in a paddock.

Carbon supplied by carbon flows is the main building block of all life in a paddock, be it grass, soil life or cows, and is responsible for keeping all life functioning by carrying energy. All rural producers sell something that has lived, be it meat, fibre, grain, hay or vegetables. Their day job is managing life.

I ask them if they know that cows are 18% carbon and if they had considered that grass is 45% carbon. I tell them that the reason the natural world can’t function without carbon flows is that carbon is the main building block of life. Agriculture produces and sells carbon products.

A producer’s day job is recycling carbon. They set out to turn some of the carbon that is flowing through the paddock into saleable carbon products like meat and grain. The more carbon that flows, the more cattle they have to sell. Selling cattle is harvesting carbon when it has entered the cattle part of the food chain.
FURTHER EXPLANATION

Getting back to the basics

When I was a producer, I concentrated on thinking out what really mattered. Get the basics wrong and nothing else will fall into place.

Management of carbon flows is concentrating on the basics. It is the most fundamental thing a producer has to get right. They have no control over how much rain arrives but they do have some control over the level of carbon flows it generates.

The carbon flows concept helps graziers to visualise what can’t be seen, to imagine what is happening on a multitude of levels and time frames. The paddock with the highest flows will be the most productive and more resilient. At the moment, most producers can see and measure outcomes, but don’t understand how they are generated.

Humans and cattle are about 18% carbon while plants are about 45% carbon. The natural world can’t function without ‘carbon flows’. This is because carbon is the main building block of all life on the planet and responsible for carrying the energy on which all life relies. Plants rely on carbon inflows to construct themselves.

The best way to understand what life includes is to think of what dies. Grass dies, cows die, soil microbes die and worms die. All rural production is selling something that has lived.

Carbon is always moving. After entering the landscape via photosynthesis, one path of carbon involves moving along the two food chains, one above ground and the other below ground. This involves moving from one living thing to another living thing. Above ground, when cattle eat grass, carbon is moving from one life form to another life form, then on to another when we eat meat. Below ground, carbon also keeps moving and maintaining soil life that is responsible for keeping the soil well structured and fertile. When humans breathe out carbon dioxide, some of the carbon that has entered our bodies (via food) moves on.

Energy, nutrients and water all follow the path of carbon. How successfully pastures are able to introduce carbon into the landscape is determined by animal management. Speaking broadly, plants and animals have evolved together and rely on each other (even if the particular species in a paddock may have originated in different countries). However, if animals dominate plants, then carbon flows are reduced. In the absence of animals, pastures become moribund and again have a lower capacity to introduce carbon.

All else being equal, the grazing paddock that has the most carbon flowing through it will be the most productive and resilient. Soils with more carbon flowing through them are more resilient because they have improved water infiltration, increased water-holding capacity and greater fertility.

The two components of paddock resilience are plant resilience and soil resilience. Allowing carbon to flow into plants increases their resilience in two ways:

- by increasing internal energy reserves for them to call up; and
- by creating a more extensive root system to give them access to more water and nutrients.

Everything discussed to this point makes management of carbon flows the cornerstone of food production, rural profit, drought preparedness, improved water quality and ability...
to meet the expectations of the broader community for better environmental outcomes, including in the atmosphere.

The above summary explains why carbon is a good starting point for systems thinking. Those who take a systems approach place a high emphasis on carbon, while those who take a reductionist science approach see water as the limiting factor in landscape health. The reality is that a grazing operation has no control over how much rain arrives. How effective rain is depends on whether it enters the soil or ends up in gullies; and in the case of water that enters the soil, whether plants are healthy enough to fully utilise it. Both these issues are determined by management of carbon flows.

Nature has designed these systems so that water activates the flow of carbon into the landscape.

**Short-term carbon is the driver**

The ‘flows way of thinking’ explains that the bulk of the carbon that is moving in the paddock, above and below ground, involves short-term carbon compounds, not long-term carbon compounds. Grass is short-term carbon.

Over a twelve month period, maybe 2% of the carbon flowing in the soil involves long-term carbon. In other words, virtually none. In the short term, long-term carbon is not driving change in the landscape.

The grazing industry does not manage long-term carbon, it manages short-term carbon. The decisions graziers make relate to management of short-term carbon. Long-term carbon is an outcome.

I am not suggesting that long-term soil carbon is unimportant, because it is. It is a resource for production and protection of the environment. But it shouldn’t be the starting point of discussion around best management.

This diagram demonstrates the short-term outcomes of changed management. It demonstrates that the changed management is reflected only in short-term carbon. The red section is the fast-moving, short-term carbon, and the black section is the slow-moving, long-term carbon. The diagram demonstrates how the ratio of short- and long-term carbon changes as soil organic carbon increases.
When soil organic carbon went from 1.5% to 2.5%, the change was driven by increases in short-term carbon – the red section. Look closely at the size of the black section, and there is virtually no change. The percentage of long-term carbon has changed on the left-hand diagram, but this is because the increase in short-term carbon has changed the total. The energy on which agriculture relies is sitting in the red pool. Also, nearly all the mobile carbon in the soil involves the red pool.

This diagram reinforces the previous one. Looking at the change out of cropping to pasture, the increase in carbon flows immediately showed up in the short-term carbon stocks (particulate) and the long-term carbon hardly changed initially. Long-term carbon has to start the journey as short-term carbon, so even people focused on sequestration have to understand carbon flows.

There is another reason why producers should be thinking of carbon flows. Phosphorus is known to be the element limiting production in many Australian pastures. The availability of phosphorus to plants is influenced by how much soluble carbon is released by plants. Soluble carbon is some of the fastest moving carbon, and its only source is a growing plant.
Why carbon needs ongoing replacement

It is critical to keep introducing carbon into a paddock, above and below ground, because carbon keeps leaving the system. This diagram explains what is happening to carbon after it enters the soil. The arrows on the CO₂ sections represent the loss of introduced carbon via consumption i.e. oxidation. Apart from fires that oxidise carbon compounds (above ground), the oxidisation process relies on one life form consuming another and releasing CO₂ in the process. The diagram highlights that the outcome of photosynthesis is being reversed with every consumption event. You can see some of the original carbon introduced as short-term carbon heading towards longer-term carbon as it becomes less and less digestible. This is represented by shortening of the horizontal red bar.

The carbon that flows in after rain initially goes into the fast-moving short-term carbon pool. Then some finds its way into the medium-term pool and finally a little into the long-term pool.

In general, 75-80% of carbon that enters the soil will be gone within twelve months. The actual amount is determined by moisture levels and temperature. This highlights the principle that if your management is not focused on carbon flows, then you run the risk of running short of this commodity.

Short-term carbon moves faster if more nitrogen is joined to it. This is because carbon compounds can be consumed faster. Cows digest high-protein diets more quickly than straw.
The different ways carbon inflows are reduced

These sheep have been sent in to totally shut down carbon flows and force plants to keep calling on stored energy in their roots as they keep trying to grow from 30 mm of rain.

When perennial grasses are not exposed to any grazing, they become moribund. Moribund grass has reduced capacity to photosynthesise and so the carbon flows it produces are lower than grass correctly grazed.

Speed of carbon

Carbon is currently labelled short-term, medium-term and long-term. An alternative concept for structuring thinking is the term ‘speed of carbon flow’. Some carbon moves very quickly through the paddock on its way back to the atmosphere. Some stays a little longer and some moves very slowly.

The individual carbon atoms notionally ‘move’ at different speeds depending on the processes in which they are involved. It is the fast-moving carbon that runs down quickly and needs constant replacement.

Carbon trading is more focused on the slow-moving stable carbon, while rural producers make decisions that apply to the faster moving short-term carbon. It is the fast-moving carbon that increases production. Stocks of long-term soil carbon are slow to change,
which reinforces the point that long-term carbon can’t to be responsible for short term increases in production.

If management increases the speed of carbon flow through livestock, then they get to market quicker. Producers also need to speed up the flow of carbon in the soil, to make nutrients available to plants sooner. The factors that speed up the flow of carbon through an animal are the same as those that speed up the flow of carbon in the soil, and this is why big picture principles need to be understood by producers.

Discussion of carbon flow helps producers to conceive of carbon as always moving. Carbon levels will run down if the flows are not maintained.

**Financial analogy**

Carbon in a production system is analogous to money in commerce. Think of cash flows versus capital. Cash flows are the fast-moving money that keeps a business viable, just as fast-moving carbon keeps a pastoralist viable. Think of the slow-moving carbon as part of the business’s capital base, just like cattle yards and buildings.

The fast-moving carbon makes money because it feeds all the life in the paddock, including the cattle. It maintains larger root systems in the grazier’s plants so that they can access more moisture and nutrients to grow. It is a component of the energy reserves that determine how well plants respond to what rain falls, especially important in marginal years. It is ground cover. It is organic matter that supplies nutrients. Erosion is an immediate reduction in earning capacity, because it removes short-term carbon; but it also undermines the asset base of long-term carbon.

**Supplementary reading on extension**

For the thirty years that I was a grazier until 2000, not once was the word carbon mentioned to me during extension. Land management was never explained in terms of carbon management. Nobody suggested to me that my day job was recycling carbon. It was not explained to me that the meat and wool I sold were actually carbon compounds, which is why I needed to maximise the flow of carbon through my paddocks. Nobody couched the debate in a way that made it obvious that the severity of droughts and how often they arrived, could be reduced by managing carbon flows better.

Dr David Freudenberger, a former CSIRO rangelands scientist and now lecturer at ANU, confirmed that my claim is true. He said land management simply wasn’t presented in terms of carbon. Dr Allan Wilson, another former CSIRO rangelands scientist said the same thing. Allan said that extension went as far as discussing organic matter but did not couch it in terms of carbon. A Queensland Country Life journalist advised me that if carbon had been seen as relevant, they would have been writing about it.

When I was on the land, extension took a reductionist approach to the science of land management and this approach still lingers in many quarters. Reductionist science puts information in silos and discusses the separate components of a landscape in isolation. Reductionist science places a much lower priority on carbon than those taking a systems or ‘big picture’ approach.

It is not fair to level any blame at the feet of people writing extension. They are simply calling on the reductionist approach that prevailed in their formative years at university.
Climate change policy is influencing how carbon is treated in extension

It was climate policy that introduced the word ‘carbon’ into extension. And herein lies the source of the current lack of emphasis on carbon flows. Funding favours applications around measurement and so carbon stocks. This sequestration perspective has become embedded in extension. One has only to consider the Carbon Farming Initiative to see that funding has been directed towards carbon stocks projects and not carbon flows projects. But stocks rely on flows.

We act according to how we see the world

It is human nature that world views – mindsets – influence the decisions people make. For this reason, achieving change relies on aiding people to see the world differently. The grazing industry is no different.

In 2008, Dr Greg McKeon wrote that future graziers will see themselves as “managers of carbon”. Today Greg would write that future graziers will see themselves as “managers of carbon flows”.

The Carbon Grazing principle

The Carbon Grazing principle is not new science, it is a new focus. The principle highlights that pasture rest is sufficient when enough carbon has flowed above and below ground to all the areas it needs to.

The principle relates to the first phase of carbon flows, which is the introduction phase, that is, when carbon moves from the atmosphere to the paddock via photosynthesis. It gives direction on maximising carbon flows. In this sense, the principle is an action plan.

There are some subtle realities that underpin the Carbon Grazing principle. Because over much of Queensland, there is no pattern to the time when rain arrives, in other words, when carbon arrives, the message is that pasture rest is TIMING and not TIME. Basing resting decisions on a certain period of TIME is no guarantee that carbon will arrive.

Carbon Grazing is short-term removal of animals from pastures. It is a practical and economical approach, because an alternative home for the animals has to be found for only a short period of time. Carbon Grazing is not the same as ‘wet season spelling’ which involves a much longer time period and places added grazing pressure on the remainder of the property not being rested.

The Carbon Grazing principle is based on the premise that in most of Australia’s rangelands, nature does not have a predictable pattern. Stated simply, we must allow
nature to transfer carbon from the atmosphere to the landscape according to its time frame.

Carbon Grazing specifies four to six weeks’ pasture rest after grass-growing rain. The period does not commence until the plants actually start growing. How long depends on the resilience of the paddock. One producer with healthy pastures is of the opinion that he can achieve full recovery after about four weeks. It is important to not get caught up on the exact time between four and six weeks, as factors like temperature influence the necessary time. Also, the health/resilience of the pasture, based on past management of carbon flows, influences the period of rest required.

Scientists I met in South Africa suggested that on average pastures, removing animals for three to eight weeks after rain increased pasture production by 50-80 per cent. Given that pasture is about 45% carbon when dried, this gives an indication of the significance of increased carbon flows, including below ground.

When people say they can’t afford to rest pastures, it begs the question, why can they afford not to.

A rangelands scientist told me recently that producers like recipes. However recipes are prone to fail if circumstances change. Carbon Grazing is not a normal recipe, it is a flexible recipe. The instruction left in the rain gauge to act and remove the animals from a paddock may be random, but the instruction to act is always based on the same criterion (grass-growing rain) and always requires the same action. The only variable is that the required rest period shortens as landscape resilience improves due to better management of carbon flows over time.

I can’t stress enough, that Carbon Grazing is a principle and not a new land management system. It underpins all successful land management systems. Cell grazing, for example, is just one way Carbon Grazing can be implemented. This is because when the rain arrives, the bulk of the cells do not have animals in them. A well-respected cell grazer commented to me, that although he locks his cells up for 120 days, which is a TIME approach, the bulk of the outcomes he achieves occurs in the first 28 days after rain.

Stating the obvious, continuous grazing never implements the Carbon Grazing phase of rest after rainfall. Letting animals eat plants when they are trying to grow after rain, reduces photosynthesis and in some cases, completely shuts it down.

The best way to gauge how well we are managing carbon flows over time is to observe the outcomes or lack of outcomes after rain. Because carbon is always moving, with some returning to the atmosphere on a regular basis, there is a need to keep bringing in new carbon. On average 80 per cent of new carbon entering the soil will be gone in twelve months. The above-ground outcomes can be even more extreme depending on livestock management or fire.

In dry years, the potential for bringing in replacement carbon is much lower. This is the time when applying the Carbon Grazing principle is even more important. It is while grasses are growing after rain, that they make soluble carbon available to mycorrhizal fungi which are located on the roots. This allows the fungi to extend out into the soil and source extra nutrients for the plants.

The term Carbon Grazing was coined in 2001 and registered the same year. So I have had 16 years to refine my understanding of the carbon flows concept. Principles allow us to understand. Carbon Grazing is strategic pasture rest. It is a flexible recipe. It is instigated on the basis of one parameter and requires only one action. This simplifies
application. Carbon Grazing always succeeds because it addresses the most fundamental thing a producer has to get right, and that is to maximise carbon flows. Get the basics wrong and nothing else will fall into place the way they should.

CONCLUSION

Once a pastoralist visualises the flows, they can visualise the dynamics of the whole system and how it functions. Carbon is the organiser as it flows through the paddock, above and below ground. Pasture has been rested long enough when enough carbon has flowed to all of the areas in the landscape that are necessary. This underpins landscape health and resilience.

The carbon flows concept extends discussion past what happens in the soil to also include what happens above ground, including carbon flowing through sheep and cattle.

Management of carbon flows is the basis of sustainable food production and catchment protection. Thinking carbon flows and the quantities of carbon entering the paddock is to be aware of how much activity is occurring in the paddock.

The landscape is all interactive – self-organised – but we ‘disorganise’ it when we mismanage carbon.

The only time resilience in pasture can be maintained or increased is in the short period after rain.

If one can’t measure a change in carbon stocks, then the carbon has to be in the flows.

The pastoralist has no control over how much rain falls but does have control over how much carbon flows into the paddock from the rain that does fall.

Current extension materials should have a ‘big picture’ introductory module bolted on to explain how the landscape functions.

Changes in the way we farm must derive from changes in the way we think. Producers need to operate with a new paradigm, a different mindset. They have to be able to imagine what is happening on a multitude of levels and time frames. At the moment, a lot of producers can see only the outcomes, but don’t understand how they occur. They need to be able to visualise the processes they can’t see happening.

When graziers let animals harvest carbon flows too early following rain, they interfere with the biophysical conduit (leaves) that are responsible for introducing carbon into the landscape.

In other words, graziers should let animals harvest only the surplus, not the means by which a useable surplus is generated. They should harvest what resides above ground after adequate carbon has flowed to all parts of the landscape, including below ground. This approach will maximise future animal production and ongoing resilience of the production base. It will also improve environmental outcomes.

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