UNSETTLED SCIENCE: TIMING THE HARVEST OF CARBON FLOWS

ALAN LAUDER

INTRODUCTION

The sequence of actions in the conduct of science, and then typically its acceptance and implementation, are referred to as Scientific Method and then objective meritocratic formation of policy. In the modern world it includes evidence – hypothesis – experiment – conclusions – peer review – publication – transfer to policy – and finally its communication to practical managers. However, this sequence does not always proceed in a logical and orderly fashion. For a range of reasons, important evidence can remain un-investigated and even if scientifically validated, conclusions can remain un-implemented.

With regard to discussion around management of carbon flows in Queensland's pastoral landscapes (rangelands), science and policy appear to have dropped the ball. This Short Communication questions why research programs and landholder assistance programs to date have not included the types of management recommendations I have made in more than 10 years of advocacy. It will be further suggested that the types of changes to extension being suggested, could have wide-ranging benefits both on-farm and also across catchments.

CONTEXT

Personal communication with Michael Gutteridge (geographer and former senior scientist Queensland Government) provided a rudimentary overview of the past 150 years of land use, as well as our present performance.

"It is suggested that almost three quarters of the Australian continent is categorised as rangelands. The grazing industry operates on some of the country's most fragile, unforgiving and least productive soils. Hence, due to the immense scale of this industry, negative outcomes from poor management can have equally extensive and often persistent impacts, be that on the rangelands or beyond including river systems and coastal areas as far out as the great Barrier Reef.

In spite of this overlap, grazing properties are managed for a surplus that is realised as a financial profit. As with all commercial endeavours, this is achieved through maximising total value of out-put whilst minimising cost of inputs and/or operation. Furthermore, the archetypal grazing property is presumed to have the capacity to regenerate, to be self-sustaining and self-regulating whilst producing a perpetual surplus, as opposed to generating profits through extracting finite resources, such as with mining.

A mix of desirable pasture plants growing on good soil, optimal animal genetics and favourable climatic and market conditions, all contribute to profitability as also does minimising aberrant stock and capital losses. However, irrespective of heritage, endowment, luck or investment, it is informed and strategic management that makes the best or worst of Mother Nature and volatile markets. There are many examples of landscapes deemed marginal which have been improved to sustain a profit, but conversely and all too often, there are many examples of good grazing lands that have been degraded, and where productivity has fallen below profit thresholds; and typically flow-on consequences have been observed to impact environment and society.

Over an arguably short ~150 years most of Australia's rangelands, that is, most of the continent, has suffered some form of degradation (McKeon 2004); sometimes unnoticed and insipid, such as species decline or loss of soil structure; and at other times rapid and discernible, such as soil decline or erosion through over-stocking during severe and prolonged drought. In many regions the averaged decadal surplus, or yield, is below a "mythical" historical production potential, albeit a loosely defined quantum. This historical surplus was achieved (or could have been achieved), and incidentally through less advanced technology, by mining the virgin landscape that had incrementally accumulated over the past 10,000 years since the continent emerged from the hyper-aridity and climatic swings of the Pleistocene. This pre-agricultural rangeland was rich in carbon, nutrient, flora and fauna, invertebrates, bacteria and fungi and was structurally and hydrologically complex. Yet although rich, it was also fragile and delicately balanced.

Ironically, even in the 21st century, the productive potential of these now compromised landscapes is typically not improving as could be reasonably expected given modern advances in technology, education and management support systems as well as the flexibility afforded by extension programs and financial and government support".

PADDOCK SCALE OBSERVATIONS

For thirty years I operated a 50,000 acre (20,000 ha) sheep and cattle property called "Woodstock" which was located at Cunnamulla in Queensland. Prior to this I studied Economics and Commerce at the University of Queensland. I sold the property in 2002.

During these thirty years, nobody ever explained to me that my day job was managing carbon, or more specifically, carbon flows. Carbon simply wasn't mentioned as part of extension.

It was an article in the Australian Farm Journal (1995) that started my journey of discovery. The journey ended in an appreciation of the importance of managing carbon flows better. This article presented my proposal of using old man saltbush plantations as a way of resting pastures after rain. The drought resistance of saltbush provided somewhere to put animals at the end of dry spells when rain arrived. The article attracted the attention of the Commonwealth Department of Primary Industries and Energy. Government interest resulted in a $272,000 Drought Regional Initiative (DRI) project being conducted by myself (on "Woodstock"), to perfect the use of saltbush for resting pastures after rain, including in average years.

This project was the beginning of my partnership with the scientific community. Over time the group of scientists I dealt with grew. Between them, they helped me gain the understanding that carbon flows were central to keeping paddocks productive, resilient, less drought prone and providing better environmental outcomes.

As part of this process, scientists educated me and I educated them. I helped the scientists join the dots and they helped me join the dots. It demonstrated that science often starts with lay people. We make the observations but don't understand what we have observed. Then scientists add rigour to the observations. As part of the process, scientists often discover issues of which they were not aware of.

CSIRO wrote a paper with me for the 1999 International Rangelands Congress where I was invited to speak. The paper was based on the final report of my DRI project which I titled "Who Does Drought Visit and When."

It was after many years of having short articles written about my ideas that I decided to write a book explaining my thoughts.

The book, "Carbon Grazing – The Missing Link" was published in 2008 and launched by the former head of CSIRO Land and Water, Dr John Williams. It united practical knowledge and scientific knowledge. The book provided the knowledge required to understand the proposal that better production and landscape outcomes relies on better management of carbon. The book focused on carbon flows as well as carbon stocks. Since the book was written, explanation of carbon flows has been further refined to discussing carbon flows in terms of the speed of carbon.

Short term carbon is the fast moving carbon and long term carbon is the slow moving carbon. It has been highlighted that because long term carbon is stable, very little is involved in carbon flows. In the case of short term carbon, it moves at different speeds depending on the ratio of nitrogen to carbon.

Management of long term carbon is really all about the management of short term carbon. Long term carbon has to start the journey as short term carbon in carbon flows.

This realisation that carbon flows at different speeds through the eco system, including through livestock, changes our former ideas to carbon and land management. Applying this understanding has considerable effect on the condition of the land for both environmental and agricultural land uses – and has policy implications for management of atmospheric carbon.

Thinking/discussing carbon flows is a different way for graziers to look at the landscape and understand how it functions. The paddock with the highest flows will be the most productive, therefore producers need to operate with a new paradigm and they have to be able to imagine what is happening on a multitude of levels and time frames. At the moment, most 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.

As a producer, I spent many years not understanding what I needed to know.

It was after observing the improvement in holding paddocks on my property during a run of years of below-average rainfall, while the adjacent large paddocks deteriorated, that I was forced to accept that it was really my management, not bad luck that was responsible for the overall deterioration of the large paddocks. This led me to the conclusion that land degradation is largely due to management, not drought. The emphasis should shift from relying on good seasons for pasture repair to concentrating more on every useful rainfall event as a possible repair agent.

TIMING, NOT TIME

My signature original contribution to the science and practice of pastoral land management is that "pasture rest is timing, not time". I started using this phrase in 1998 and it was the title of my poster judged the best poster at the 2008 Australian Rangelands Conference.

Pasture rest is strategic. The reason resting/spelling pastures in the short period after rain is so important, is that this is the period when the bulk of the carbon flows into the landscape to maintain it. A paddock can be locked up for a long period of time but this is no guarantee that carbon will flow in. Removing animals to protect the height of ground cover is an important strategy but it is a separate issue to maximising the inflow of carbon.

In other words, graziers need to be harvesting only the surplus, not the means by which a usable surplus is generated. They should harvest what resides above ground after adequate carbon has flowed to all parts of the landscape. This approach will ensure future animal production and ongoing resilience.

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

It was during a trip to South Africa in 1998 that I had a discussion with a researcher at the Grootfontein Research Institute. This discussion really focused me on outcomes in the short period after rain. He said that their research had determined that 3-8 weeks of rest after grass growing rain increased pasture production on average by 50-80%. Remembering that pasture is about 45% carbon when dried, the increase in ground cover they documented, provides an approximation of the increased level of carbon flowing into all parts of the landscape above and below ground.

The Carbon Grazing principle suggests that after 4-6 weeks, sufficient carbon has flowed to all the required locations above and below ground. The actual time required depends on how resilient the landscape is as well as the prevailing temperature.

I coined the term "Carbon Grazing" in 2001. The term refers to management that maximises carbon flows. We can't change how much rain falls however we can change how much carbon flows into the paddock from what rain does fall.

After carbon enters the landscape, it keeps moving until it ends up back in the atmosphere. Potentially, a very small percentage of each inflow can remain in the soil. Carbon Grazing is about maximising the first phase of carbon flows, being the transfer/introduction of carbon from the atmosphere by plants for their own construction above and below ground and release as soluble carbon to soil life. After entering plants, carbon then continues its journey above and below ground to achieve all the positive outcomes that are well known to farmers, gardeners and scientists alike. It activates so many processes as it keeps moving before eventually returning to the atmosphere. Carbon has been described by one discussant as "the organiser". The speed of carbon refers to how quickly individual carbon atoms are moving on the way back to the atmosphere.

It is letting more carbon flow into both plants and the soil that increases the resilience of the landscape. In a perfect world, pastures would be rested after every rainfall event, however sufficient resting is occurring if resilience is being maintained over time.

I am informed, a preliminary review of grazing management articles, and related scientific literature found that in peer reviewed journals (and despite there being several soil science companies consulting on various aspects of soil carbon across various industries but not specifically rangeland grazing), substantial funding has/is available for research to increase farm productivity through soil improvement and also carbon sequestration; no where do the two seem to be linked. However, it was found that already most of the literature already substantiates my claims. Yet according to the reviewer:

"I cannot find anywhere in the literature or reference to a variable/parameter in grazing management software specifically discussing the idea of spelling pasture for 4 - 6 weeks after rain, especially in average years. Indeed, several government publications allude to this being the best time to graze due to the best C:N ratio, that is, digestibility. They refer to the importance of allowing pasture grasses to set seed but don't quite connect to the insight that grazing after rain knocks pasture about and damages the long-term productivity and resilience to drought" (Gutteridge, M.).

Furthermore, many scientific projects simply overlook some of the important variables. Some projects I have seen don't differentiate between different plant species – but grazing animals do differentiate.

Warwick Jones provided the following insight into my work:

> Alan
> KEY INSIGHT IS SPEED OF FLOWS
> We have been continually refining our understanding of the carbon cycle for more than a century but the way it has been used for both biosphere-atmosphere interactions and the resulting management practices has been fairly unhelpful to date. In particular, we have focused too much on carbon stocks to the detriment of flows. Your first insight was to realise that from a management point of view, it was the carbon flows that were important. *The key insight however, and one that I don't think anyone else has made, was that the speed of flows was the critical thing for the land manager.*
>
> In other words, it was not just the slow moving carbon we have been treating as stocks that was important but also the fast moving carbon initially introduced as part of plant growth. From a management point of view, this has meant that land managers can stop trying to drive using the rear view mirror to look at what has already happened (carbon stocks) but can now look through the windscreen and look at what the fast flowing carbon is doing before their eyes. Knowledgeable producers know how to increase the volume of carbon flowing through their paddocks as well as what increases the speed of the fast flowing carbon.
>
> This turns the current approach to land management on its head. Carbon flows move to the centre of land management not just because of greenhouse gas abatement potential but also for the profitability, sustainability and resilience of the land whether it is a vegetable farm, grazing operation or an arid lands national park. So rather than being nice to have just as a sustainability issue, carbon flow management should be the superstructure of land management thinking to which we can bolt on other modules.
>
> With the understanding of the speed of carbon concept, comes a better understanding of animal performance. Apart from flowing through the landscape after entering plants, carbon also flows through sheep and cattle. Increasing the speed of carbon through these ruminant animals increases profits and reduces the production of methane per kg of production.
>
> Warwick Jones
> 1 June 2014
>
> *Warwick Jones has been involved in the development of sustainable land management as a large producer, coordinated and directed research and public policy for thirty years.*

Given long term soil carbon is slow to change, except with erosion, the indicator of a paddock being well managed is the level of short term carbon relative to recent rainfall.

This is not to demean the work of the experienced and knowledgeable scientists, simply to say that observations from practitioners can add richness or new perspectives to scientific investigation and there should be formal avenues for them to be accommodated.

THE CARBON GRAZING BOOK

My Carbon Grazing book was published in 2008 by South West NRM Ltd, the community-based natural resource management body responsible for the mulga lands of South-West Queensland. The Chairman wrote in the foreword of the book, "My Directors and staff were so impressed with the importance of the book's message and the quality of the writing that we are providing a complimentary copy to every rural landholder within the region." It was written in communication with several eminent scientists in this field, and thereafter edited for scientific rigour by Michael Gutteridge

A cattle producer at Gladstone told me only recently that after reading the book, he changed his management and increased his calving rate from 50% to 85%, wasn't stressed by the recent dry and nutrients are now not running off his paddocks onto the Reef. He added that these better outcomes were achieved in conjunction with a new higher stocking rate he was able to implement.

That my findings about the broader aspects of spelling pastures after rain are significant, does not depend upon recent initiatives aimed at sequestering carbon because of climate change. My observations began well before climate change moved to its prominent place on the policy agenda. They are based/justified on the grounds that increasing carbon flows through the soil and above ground, increases both productivity for graziers and maintains environmental health. Mitigation of emissions and/or the prospect that graziers might earn an income from selling carbon stocks are potential but downstream benefits. Carbon units could be described as an alternative to cattle and sheep as vehicles for earning income but do not change the basic elements of a well-functioning landscape.

The failed RM Williams Agricultural Holdings attempt to generate carbon credits via the Carbon Farming Initiative, was based upon destocking. In contrast, my model which is based upon increasing food production by increasing carbon flows, also produces better greenhouse outcomes at the same time. There can be two positive outcomes from the same action (changed management), not to mention other environmental outcomes like better water quality. It is a low cost solution that relies on better, but simple/uncomplicated knowledge of how the pastoral landscape functions.

OFFICIAL LACK OF RESPONSE

I cannot claim that my insights have remained unpublished. Apart from my own published material, mine was one of ten case studies in a book called *Graziers' experience in managing mulga country* published by the Queensland Department of Primary Industries in 2000. The ABC 7-30 Report and ABC Landline both went to "Woodstock". From time to time the mainstream weekly newspaper *Queensland Country Life* has published articles publicising my work, as has *Beef Central*. The *Australian Farm Journal* has published numerous articles. The Colorado State University in the USA made my book, along with another book, compulsory reading for their course AGRI 632. Unfortunately this recognition is having zero effect on policy and extension in Queensland.

As an extension resource, the Queensland Government relies on a module called "MLA Grazing Land Management workshop notes". It is 205 pages and the word carbon appears only twice, the first time as carbon dioxide, the second time stating that carbon occurs in trees. There is no reference to carbon flows because there is no focus on carbon at all. When the manual makes reference to ground cover, it does not explain it as a carbon compound, remembering that pasture is about 45% carbon when dried. It also makes no reference to the level of ground cover being influenced by the level carbon flows.

They discuss ground cover in terms of not consuming too much (important) but do not discuss increasing carbon flows to provide more ground cover for consumption. Consumption should be the second-order issue, with the first one being management of carbon flows to increase ground cover prior to consumption. Consuming flows after they have arrived is very different to reducing the flow of carbon in the first place. Flows end up above and below ground with animal consumption only involving what ends up above ground. What animals eat is the conduit for carbon flows, so the real issue is when should the conduit be consumed. Eating the conduit too early results in lower flows arriving above ground for consumption by livestock. Eating the conduit too early also results in lower flows going below ground. This reduces the resilience of the landscape by reducing the resilience of plants and the soil.

Extension is currently taking a reductionist science approach and giving raw information to producers in separate packages, however history has shown that they are often the least capable of putting it all together to form a big picture understanding. Having an introductory carbon module would help producers better understand the big picture and see how all the separate components currently explained to them fit together.

I have made several approaches to the Queensland Government at the highest political level suggesting that their departments produce a standalone carbon module to help producers better understand current extension. An introductory carbon module would prepare the mind to understand the big picture.

This does not entail changing or rewriting current extension. Instead putting it in a more holistic context by completing the mix of knowledge producers require. A title for the carbon flows section of the module could be, "Managing carbon flows for increased profits and a healthy landscape."

THREE OBSTACLES

I am convinced that my findings summarised in the slogan "Pasture rest is Timing, not Time" dating back to 1998, are original and are important. But they have not been taken up either by active scientific research programs or by policy analysts. For my field observations and conclusions to be mainstreamed into public policy, they need to be validated by scientifically corroborated measurements presented through accepted scientific procedures.

My experience has led me to conclude that there are three significant institutional obstacles to building knowledge from non-credentialed observers into practical guidelines that land managers can adopt.

The first is that evidence arising from sources outside current experimental projects is easily dismissed. Scientists working in government and semi-government organisations like universities and CSIRO have a full work programme ahead of them. In some cases no doubt, completion of the projects on their work program is a pre-condition to gaining continuing funding, or promotion, or even retaining tenure. Given these pressures, practising scientists do not have the luxury of being receptive to ideas or data outside their processes. I acknowledge the Queensland University which is including my approach in a new course and the Colorado State University as exceptions.

The second and related obstacle, is that far too much science is reductionist. Reductionist science leads to reductionist policy. My mission does not easily conform to current traditional grant programs for environmental research, partly because it is not reductionist, partly because it bridges the environmental and agricultural disciplines and partly because any project with "carbon management" in the title is out of official favour at the present time in Queensland. Also short term carbon runs a long last to long term carbon in Federal funding programs.

The third obstacle is that once observations have been validated by credentialed scientists, there can be long gaps before they work their way into policy and management practices. This is not because the policy officers and extension staff are resistant to learning, but because they already have a body of information that has historically been settled science and this has gathered significant institutional momentum.

Michael Gutteridge has suggested turning to the banking industry, as it is in their interest to see producers have better knowledge to protect the bank's investment and also produce more reliable cash flows. Banks have or ought to have a long-term interest in protecting the condition and productive capacity of the land and in understanding what is happening on the land as part of focusing on their bottom line. However, financial institutions are unlikely to insist on an innovative approach to property management unless it has been thoroughly validated by mainstream scientific or agricultural institutions.

CONCLUSIONS

I am confident that my insights are robust. Ongoing discussions with scientists and producers has supplied the evidence. I'm also confident, through my contact with scientists in South Africa, the United States and elsewhere that these insights are applicable to other pastoral systems elsewhere. However, these insights need to be validated through rigorous experimentation. In particular, my estimate that pastures need to be spelled for 4 to 6 weeks after pasture growing rain needs to be conclusively demonstrated in Australia to the satisfaction of government policy makers and leaders of industry.

Placing a positive perspective on the issue, had I been a participant in mainstream scientific investigation, I may not have been permitted to investigate the fields I have. Now that my partnership with generous scientists has broadened my understanding of landscape function, how can I get this thinking into mainstream processes?

Given the centrality of an understanding of carbon flows to understanding how carbon can be sequestered in landscapes and hence to mitigation of carbon emissions to the atmosphere, I'm keen to hear from any scientist, in Australia or elsewhere, who would like to take up my observations on grazing management and build them into a mainstream program of scientific experiment and validation. The increased period of rest required for unresilient pastures also needs to be investigated and quantified. The importance of feedback loops from past carbon flows needs to be part of the investigation.

ACKNOWLEDGEMENTS

I wish to acknowledge Michael Gutteridge for reviewing literature and writing the "Content" sections of this communication.

LITERATURE CITED

BEEF CENTRAL. 30 June 2013. "RM Williams carbon projects plunge into receivership". http://www.beefcentral.com/news/rm-williams-carbon-projects-plunge-into-receivership/

HEATH, JOHANNA. 20 Mar. 2014. "Soil carbon scheme may be blind hope". *Queensland Country Life*. http://www.queenslandcountrylife.com.au/news/agriculture/agribusiness/general-news/soil-carbon-scheme-may-be-blind-hope/2692339.aspx?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter

HEYWOOD, JILL ET AL. 2000. *Graziers' experience in managing mulga country.* Brisbane: Department of Primary Industries, Queensland. Information series QI00078.

MCKEON G. ET AL. 2004, "Pasture degradation and recovery in Australia's rangelands: learning from history".

O'SULLIVAN, DAMIEN. 2013. *Pasture Management for South East Queensland*. Brisbane: Department of Agriculture, Fisheries and Forestry.

This short commentary is an edited version of a presentation made by Mr Lauder to a seminar "Research as a form of infrastructure" convened by the Society on 13 June 2014.