Soil Carbon: Sound Science or Snake Oil?

How Sound Is The Science of Soil Carbon In Australia?

Carbon Farmers of Australia

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About This Paper

This paper has a single intent: to prosecute the cause of urgent action against Global Warming in the face of degenerating climate conditions. We believe that soil carbon sequestration can delay the progress of Global Warming while the infrastructure necessary to produce energy and food without high levels of destructive emissions can be chosen and scaled up to critical mass. Leading scientists James Hansen (NASA) and Rattan Lal also believe this to be so. We call it The Soil Carbon Solution.

The deployment of offsets market mechanism that will power The Soil Carbon Solution in Australia has been entrusted to "Science" in the belief that the scientific community 1. Is capable of responding and 2. Is committed to its success. Neither is necessarily the case. While business is expected to make significant changes to the way it operates in the face of Climate Change, Science demands to continue "business as usual", citing the strictures of Scientific Method. It appears that the generic structure of scientific inquiry works against effective, timely responses to urgent issues such as Climate Change..

"If you have to wait for perfect science it will be too late!" says Dr Graeme Pearman, formerly climate science chief at CSIRO. "Science pursues 'truth' and thus typically lags, searching for certainty."

"I think the issue of climate change is so urgent that it would be a mistake to say we have to put this off to wait for better science. I do not think we need perfect science and perfect understanding to be able to start providing incentives for landholders to build soil carbon." Professor Annette Cowie is Director, National Centre for Rural Greenhouse Gas Research, University of New England.

While this document contains a critique of the way the science of soil carbon has been managed, it is not meant to be a critique of any individual. Many scientists have donated much of their time to speaking at our conferences and educating/ mentoring members of the Carbon Coalition, at some risk. The Coalition is grateful for their generosity and courage.

What Scientific Objectivity?

The slide below[1] illustrates how distressed some in the science community can become about the prospects of soil carbon offsets. The slide also illustrates the danger of allowing scientists make 'expert' pronouncements about the structure of markets and commercial matters: Eg. "A drought can mean… you have to pay the new owner back…" is completely wrong. In no offsets trading scheme to date or planned does the grower stand alone unprotected against disaster. A "buffer pool" system sees the grower self-insure by 'banking' more tonnes than they offer for sale. Additionally, individual growers are protected by the broader pool.

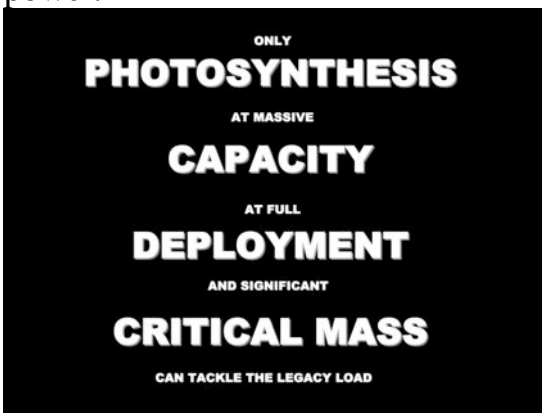
The use of language in this slide also creates a misleading impression. Eg. "Once sold, you manage for the new owner." This implies that buyers of offsets gain property rights, which is not the case. The intent of such language is to create fear among farmers and turn them away from the soil carbon opportunity.

[1] Dr Richard Eckard, The Challenges and Opportunities for the Agricultural Sector Under an Emissions Trading Scheme Slides, 2007,

The Soil Carbon Solution

It is the ultimate spill-over community benefit arising from RDC research: carbon sequestration in agricultural soils. The world is waking up to the fact that limiting future emissions will not be enough to avoid catastrophe. "The science now tells us that it will be next to impossible for nations to achieve the scale of reductions required in sufficient time to avoid dangerous climate change unless we also remove carbon from the atmosphere and store it in vegetation and soils." *The Wentworth Group of Concerned Scientists believes:* "The power of terrestrial carbon to contribute to the climate change solution is profound."[2]

Awareness of the need for a short term fix for Climate Change is growing. The 'vintage' CO2 already in the atmosphere that is doing all the damage cannot be captured by "clean coal" technology and immobilized by geosequestration, the solutions favoured by the Australian and US Governments. Nor is it the CO2 that will be avoided when power is generated by solar or wind turbines or hot rocks or nuclear power.



The damage is being done by GHG that can't be captured at source or substituted. It has to be scrubbed out of the atmosphere by the only means possible: the natural processes that lock carbon up in trees and soils.

PHOTOSYNTHESIS.

Professor Rattan Lal, the world's leading soil carbon research scientist and IPCC lead author: "Carbon sequestration in soil and vegetation is a bridge to the future. It buys us time while alternatives to fossil fuel take effect."[3] Dr Tim Flannery,

[2] Optimising Carbon in The Landscape, October 2009

[3] Rattan Lal is director of Ohio State University's Carbon Management and Sequestration Centre, professor with the School of Environment and Natural Resources, and recipient of the 2006 Liebig Applied Soil Science Award. Lal has spent 18 years of his service with Ohio State's Ohio Agricultural Research and Development Center (OARDC) studying carbon sequestration. In 2005, Lal was the recipient of the Norman Borlaug Award, another international honor for his contribution to the sustainable management of soil and natural resources, specifically carbon sequestration and global food security. He has received over 14 other distinguished awards and

Chairman of the Copenhagen Climate Council, says soil is "the fastest way of sequestering carbon… The strongest prospect of very large draw-down of atmospheric carbon lies in changes to our global agriculture and forestry practices," he says. He acknowledges capacity of the 4 billion hectares of rangeland. Increase the soil carbon in 'world's dry rangelands by a mere 2 per cent… we could pull down around 880 gigatonnes of carbon from the atmos-phere."[4]

The crisis of our soils is urgent. The crisis of Climate Change is urgent. The crisis of farm finances is urgent. The crisis of rural communities is urgent. The urgency of the need for widespread action by farmers makes the financial incentive essential to speed uptake.

Australian and international security bodies predict 40 million climate change refugees could be moving in our area within 50 years.

The world will need to grow twice as much food in 50 years' time with the same amount of soil and the same amount of water.

At the same time, the Food & Agriculture Organisation of the United Nations, the World Bank, the USA, the EU and food and farming organizations believe Agriculture has a special role to play in that the world's agricultural soils have the capacity to draw down the equivalent of 50ppm by 2100[5] – stalling the process of Climate Change long enough for alternative sources of energy to reach critical mass.

Science's Achilles Heel: Urgency

If the Global Community limits its response to Climate Change to those solutions coming from Formal Science, it is doomed to

has authored, reviewed and edited over 1,000 publications and journal articles throughout his career.

[4] Flannery, Tim, "Now Or Never", Black inc., 2009/

[5] Rattan Lal, "The Potential for Soil Carbon Sequestration" in Agriculture and Climate Change: An Agenda for Negotiation in Copenhagen, International Food Policy Research Institute, http://www.ifpri.org/2020/focus/focus16.asp.

exceed the 2°C increase in mean global temperature that scientists believe will take us into unchartered waters.

Science is not equipped to innovate rapidly in an emergency. Rapid innovation requires rule-breaking and risk-taking. Science cannot act this way because it would undermine the process by which a fact becomes "scientific".

Scientific information is the "most reliable" knowledge available because its findings are 'repeatable', ie. they can be reproduced in other places by other people.[6] This claim locks Science into a "Scientific Method" which sets the ground rules for gathering and analysing data. This involves the entire scientific community in verifying the work in a process called 'peer-review'. Unless a piece of research is accepted for publication in a scientific journal, after being assessed as acceptable by three or more 'peers' (or scientists in the field) it does not exist, officially.

The Science system acts as a sheet anchor on timely innovation.

Stage 1: The solution must compete for the attention of recognised scientists, against a large number of fashionable candidates. Eg. Biochar was championed by prominent scientists long before soil carbon was finally recognised.

Stage 2: The project must compete for funding – which means the scientist's skills in 'grantsmanship' will see many worthy projects overlooked. Stages 1 and 2 can take up to 10 years.

Stage 3: The research itself. Soil carbon science requires 3-year trials, according to tradition. This is despite the prevailing opinion that no significant shift in soil carbon levels will happen in under 20-30 years.

Stage 4: Seeking a publication. This can consume 18 months on average. This point introduces the 'peers' who might recommend changes to the paper. Naturally a small coterie of scientists review each others' papers, such is the structure of the community.

The "Peer-Review" Process can make a new candidate for 'scientific factness' wait 15 years before it can be acknowledged as scientific and acted upon by Government. Throughout this period Science will not abide discussion of the candidate fact as a potential solution. It presents the only peer-reviewed data as the sum total of Science's knowledge, no matter how old or out of date the data. In fact, Science will actively discourage consideration of

[6] Judging Science: Scientific Knowledge and the Federal Courts- Kenneth R Foster, Peter William Huber - 1999

candidate facts, no matter how urgent the need for new solutions. This is especially so when the solution originates among non-scientists.

Agricultural Science has been dominated by chemical technology coming from multinational petrochemical and pharmaceutical corporations. This is known as 'high input' farming, whereby farmers pay high prices for artificial nutrients and biocides (herbicides, pesticides, fungicides). The soil is used as a medium for delivering water and synthetic nutrients to the roots.

Alternative practices developed by farmers and pastoralists – which replace reliance on industrial processes and products with soil management practices that restore the soil's natural microbiological communities to health which, in turn, make nutrients and water available to plants while growing soil carbon stocks - are called 'low input' systems because farmers rely less on externally-provided products and processes, which reduces costs and makes it easier to make a profit. There have been many attempts to suppress these approaches, particularly the soil carbon opportunity, by such means as the following:

- No research funds are sought for them for many years.
- Desk research purporting to reveal the potential of Austrtalian soils to sequester carbon ignores the lack of data on alternative practices. A skewed conclusion becomes lore.
- If the practices become popular, research is conducted which, due to methodological failures, invariably finds that the practices are not effective.
- Spokespeople on the payroll of major Government-funded research agencies conduct a media campaign to discourage adoption of the grassroots innovation.
- "Scientific" papers using 50-year-old data claim to prove the practice is too hard, too expensive, or otherwise a bad decision.
- Articles based on this data are published in official research agency newsletters and magazines.
- Seminar series are conducted, to 'debunk' the candidate facts.
- Senior scientists describe the promoters of candidate facts as 'snake oil salesmen'. Personal attacks on the integrity of scientists, agronomists and others engaged in promoting alternative methods appear in scientific papers and reports.
- The old 'peer reviewed' data is presented to government

enquiries and used to populate computer models which are then used to estimate the effectiveness of these alternative practices.
- Senior scientists declare the scientists and agronomists working on the candidate facts as not qualified to make presentations to government on the issue.
- Government-funded institutional research bodies finance such 'propaganda' activities.

All these activities have been directed at farmers who would promote the Soil Carbon Solution.

A Plea For 'Sounder' Science

This submission is not a plea for less rigorous science. The opposite is the case. The Carbon Coalition believes that the science of soil carbon has been conducted in ways that Official Science would describe as 'sound', but which are in fact unsound.

Science is sacrosanct in our society. It is also poorly understood. It is deferred to as authoritative and rarely questioned. Scientists therefore have a responsibility to use their status ethically.[7]

In the field of Climate Change, policy makers habitually refer to initiatives going ahead provided the 'science is sound'. 'Sound' can be replaced by 'robust' or 'reliable'. But 'unsound' science looks the same as 'sound' science to a non-scientist.

Although it is considered to be above politics and free from personal agendas, Science is a human institution and hence is subject to all the social and political dimensions of life. The discipline of Science is organised as a self-regulating community of professionals who control the education and admittance to the industry of new practitioners. It controls the output of its members via a system called 'peer review'.
The "Scientific method" claims to be based upon 'objectivity' – ie. the inquiries of its members are free from the influence of personal values or outside interests. However Science is readily influenced by its sources of funding and the self-interest of its members. For instance, the choice to follow the path of Industrial Agriculture after World War 2 was made under the influence of the major global fertiliser and chemical companies. They in turn funded research and education.[8]

[7] Many scientists in the soil carbon debate comment on matters of likely market protocols and structures, of which they have no special knowledge. Their comments – which are misleading in most cases – are never predicated by a declaration of ignorance and lack of expertise.

[8] Soil science education in New Zealand is funded by the fertliser industry.

Education in turn was fashioned to meet their needs, ie. the chemistry and the physics of soil were taught to undergraduates almost exclusively. Chemistry is the language of the chemical companies. Physics because the soil was conceived of as a delivery medium for water and nutrient inputs for plants. Some scientists believe the role of soil is to hold plants up and deliver chemicals to the roots: "There is little scientific evidence to suggest that organic matter has any unique properties that cannot be done without," asserted P.E.V. Charman and M.M. Roper in the textbook SOILS in 2000.[9] Soil Organic Matter – mainly decomposing plant material – provides food for the billions of microbes which make nutrients available to plants and determine soil health and productivity. It is largely generated by 'natural farming' methods, rather than by Industrial Agriculture.[10]

It is hard to believe that a GRDC Research Update in 2007 would report that: "The lack of experimental evidence, under Australian conditions, of the benefits of increasing soil organic matter has also led some scientists to question the appropriateness of advising growers to increase organic matter inputs." In the same report the GRDC revealed that its experiments had provided evidence that: "Increasing the amount of organic matter throughput will boost soil organic carbon levels."[11] It is significant that this research project was not initiated by Science but by growers concerned about the sustainability of their continuous intensive cropping systems, largely due to declining soil structure. Soil organic matter and soil organic carbon lead to the third leg of the stool – Soil Biology – long neglected because it offers an alternative source of nutrients via microbial processes and is negatively impacted by the tools of Industrial Agriculture such as biocides (herbicides, pesticides, etc.).

The Scientific Community's hostility towards 'natural farming' practices that work to maximise microbial contributions to fertility can be understood in this context.[12] Its sustained campaign against the

[9] Charman, PEV and Murphy, BW, Soils: Their Properties & Management, Oxford, 2000

[10] Natural farming techniques include grazing management, pasture cropping, biological farming, Biodynamics, Natural Sequence Farming, etc. See the Carbon Farming Handbook, Carbon Farmers of Australia, 2010.

[11] Research Update – Maintaining the productivity of soils under continuous intensive cropping [16 August 2007] http://www.grdc.com.au/director/events/researchupdates?item_id=8725C123EF744252E73E079F39D567BD&pageNumber=1

[12] CSIRO's enthusiasm for Genetically Modification from Monsanto con tinues this tradition of alignment with Industrial Agriculture.

notion of soil carbon offsets or credits as an incentive for farmers to change their land management practices so as to sequester carbon can be understood from the same viewpoint. Carbon credits encourage changes in behaviour towards more 'natural' methods. Many of those opposed to it are employed to achieve through education, encouragement and extension the changes that the market for offsets will produce. Given the aggressive free market for research funds that successive Governments have created and the long term defunding on soil science for a decade, it is understandable that, until the science and extension community can see a role for themselves in the Carbon Economy, their opposition will continue.

Science needs educated, informed policy-makers as customers who can interpret the context of its output which can change the meaning of its findings.

The Problem of Scientific Objectivity

Scientific information is claimed by scientists to be the only "reliable" knowledge because it is created in a culture of objectivity. Objectivity in research gives researchers trustworthiness, according to Dr. Annabel Fossey of the Council for Scientific and Industrial Research (CSIR).[13] "This applies to both the tasks of setting up the research and gathering the data and in the tasks of interpreting and publishing the results."

"It is of growing concern how often research integrity is currently being challenged, and how common "unprofessional" behaviour seems to be in research today… Researchers knowingly or intentionally ignore some of the most fundamental rules of research. Experimental designs and analyses are biased, results are reported inaccurately or incompletely…"

The popular belief is that science is beyond opinion – unsullied by the scientist's political or personal views. This is not correct. "Science is not an idealized interrogation of nature by dedicated servants of truth, but a human process governed by the ordinary human passions of ambition, pride and greed," conclude William Broad and Nicholas Wade in their report *Betrayers of the Truth*[14], a comprehensive survey of scientific fraud. "The claim of science to represent a reliable body of knowledge rests four-square on the assumption of objectivity, on the

[13] Dr. Annabel Fossey, "Research ethics and agricultural innovations", Council for Scientific and Industrial Research (CSIR), South Africa 28/07/2008 http://knowledge.cta.int/en/Dossiers/S-T-Issues-in-Perspective/Science-and-ethics/Articles/Research-ethics-and-agricultural-innovations

[14] Oxford University Press, 1985

assertion that scientists are not influenced by their prejudices or are at least protected from them by the methodology of their discipline." But methodology is the area most open to mistake.

How "Sound" Science Can Be Unreliable

There are three fundamental ways scientific research can produce unsound results:
1. the design of the experiment fails to replicate the conditions on the farm to the extent that it skews the results;
2. the data sets selected for analysis are not a statistically accurate representation of the phenomena being studied; and
3. the reporting of results ignores some aspects and makes prominent others in an unbalanced manner.

The causes of these flaws in scientific method can be fourfold:

1. ignorance of farming conditions
2. lack of farming skills
3. predisposition to anticipate outcome
4. predisposition to explain away findings (paradigm defence)

Following are three case studies where 'sound science' led to unsound results.

Case Study 1: Design of Research Methodology

Science can produce inaccurate results if the methodology adopted to simulate farming practices is unrealistic. For instance, in 2003 (just 6 yearsago) The Australian Journal of Experimental Science published a scientific paper titled "Effects of Grazing and Management on Herbiage Mass..." 2003, 43, 892-905. They were trying to test the claims of Holistic Management and Grazing For Profit's rotational grazing management systems that they produce more vegetation than conventional grazing. Practitioners of these grazing techniques will tell you that it can take approximately 7 years for the full impact of grazing management to kick in with any dramatic results, unaided. It seems that the soil biology has to reach a critical mass. As well, anything less that 35-55 paddocks defeats the purpose because rest (or freedom from grazing) is the key variable in vegetation growth. Animal impact - bunching them up so that they graze the paddock evenly, disturb the topsoil and fertilise it with their dung and urine - is a key part of the system, which is why such a time controlled grazier would graze 25-500 sheep per hectare for the period of grazing, which is in some cases a day or in many cases less than a week or two weeks.

Table 1. compares the simulation of the land management technique was designed for the experiment with reality of how that technique is practiced.

Table 1.
Sound Science Case Study #1:
Determining Outcome of Scientific Experiment
by Selection of Methodology

	What is needed to effect change	What the experiment tested
Paddocks	35-55	2-4
Grazing rest periods	150 days	84 days
Stock density	25-50/ha	3/ha
Time to make change	7 years	3 year

Naturally the researchers concluded that there was no effect on herbiage mass from rotational grazing. Therefore, they concluded 'recipes' (exotic grazing management systems) don't work. One alternative explanation that they did not consider was that they were not good rotational graziers. And had they been aware of what was necessary to make such a system work, perhaps they would have produced a more useful research result. As it is, this piece of research adds little to the knowledge base, but it was given the status of 'scientific fact' by virtue of its publication and no doubt used by extension officers and district agronomists to knock rotational grazing systems which are taught by the organisations mentioned above which engage their students in a mentoring relationship, which means they no longer rely on the extension staff for advice. They also promote a low-chemical/low artificial fertilizer regime which most extension officers would not have encountered in their training.

But had practitioners been part of the research team and allowed to have input on the methodology, the findings would be more useful. The phenomenon of scientists being unable to verify what farmers on the ground are finding was demonstrated in a paper called Production-Oriented Conservative-Impact Grazing Management. It was prepared for a WA

Department of Agriculture workshop in 2002, by Professor Ben Norton. He points out that the majority of published research studies of rotational grazing find that continuous grazing is better than or comparable to rotational grazing in terms of either animal or plant production. Yet "Hundreds of graziers on three continents claim that their livestock production has increased by half or doubled or even tripled following the implementation of rotational grazing…" The answer to the conundrum lies in the methodology adopted by the scientists: the research trials employed only 16 paddocks or less in the rotation. A typical real-life rotational cell will have 40 to 80 paddocks, the high numbers affecting the amount of time animals are intensively grazing each paddock and the amount of time the paddocks have to recover.

The same problem of methodology led conventional science to vastly under-rate organic agriculture, according to Dr Charles Benbrook, Chief Scientist of the Organic Centre:

"Much of the past research comparing "organic" and conventional systems has been flawed. One of the reasons that many studies done by academic scientists have failed to find consistent differences between conventional and organic food is because the scientists have based their field research on university experiment stations that have been farmed conventionally for twenty, thirty, or a hundred years. They attempt to convert some acreage to organic production, but typically do it quickly, accepting certain "compromises." They are simply not able to grow crops as skillfully as an experienced organic farmer. They don't have the time to build up their personal farming skills to match those of good organic farmers. They lack the time to work with a piece of land for five, ten, or twenty years in building up its fertility and capturing all of the biological benefits that are associated with organic farming."[15]

Case Study 2: Selection of Data Sets

There is a widespread belief among scientists and agronomists that Science has proved that Australian soils have little potential to sequester Carbon. In fact, no scientific studies have tested the potential of Australian soils to sequester carbon where 'potential' means the maximum possible under ideal conditions[16]. The research program on which the National Carbon, Accounting System (NCAS) was based

[15] The Science of Organics: Peeling the Onion to Reach Core Truths http://www.organic-center.org/res.lead.benbrook.html

[16] The peer review methodology disqualifies options for evaluation of "potential" until they have passed through the research-report-review-publish process.

suffered from methodological flaws which led to gaps in the data and unjustified conclusions. The authors of one major report have agreed that the paired sites chosen for analysis were unrepresentative of the land management techniques that are widespread today. Scientists have pointed out that the case studies reviewed in another major report are out of date.

Analysis of Technical Reports 34[17] and 43, the core data reports for the construction of the NCAS inventory of emissions for soils, reveals that the data sets are incomplete, focusing almost exclusively on conventional rather than regenerative land management techniques. It studied only soils managed in ways that caused losses of carbon rather than soils managed in ways that capture and store carbon (ie. regenerative land management techniques such as biological farming, time controlled grazing management, pasture cropping, etc.)

Farming has changed in the 20 years since most of the studies reviewed for NCAS were done. The scientific methodology was flawed because it did not choose a representative range of samples. For this reason, there are gaps in the data sets.

Therefore the data cannot support the conclusions being drawn from it. The authors of these reports warned against relying on them for definitive conclusions

The consultant hired to assess the data sources was also concerned:[18] "There are also considerable deficiencies in the completeness of the data… In many established agricultural areas, there are practical difficulties in finding true pairs… The approach is limited by gross lack of data…"

The Australian Greenhouse Office admitted that the data was insufficient. "Development of the NCAS was undertaken with the clear understanding that data would be imperfect, but that the significance of data limitations could be assessed only in a functional integrated system." [19]

The AGO took a 'fix it in the mix' approach: "The tacit acceptance of variability in data provides for a proper focus on matters of accuracy and bias, rather than on potentially unachievable precision." The Agency believed the sheer weight of data points would carry

[17] *Technical Report No. 34 Paired Site Sampling for Soil Carbon Estimation – NSW, National Carbon Accounting System, Australian Greenhouse Office, January 2003*

[18] *Estimation of Changes in Soil Carbon due to Changed Land Use National Carbon Accounting System - Technical Report No. 2 November 1999*

[19] *"Methods for Estimating Land Use Change Emissions ", Factsheet, National Carbon Accounting System, Australian Greenhouse Office, August 2002*

the day, provided there was no bias in the inputs: "Over a large sample … a national inventory derived from an aggregation of fine-scale events can provide a robust central estimate provided inputs are not biased." But the inputs were biased.

Most official studies recorded poor carbon performance because they studied only traditional techniques which are destructive of soil carbon.

They did not find sequestration because they weren't looking for it. They were looking for declining carbon. They found it. There are several trials underway to fill the gaps, further evidence that the gaps existed and the conclusions were unsustainable.

Despite the lack of official data, there are many indications that Australian soils can sequester significant amounts of carbon.[20]

Case Study 3: Interpretation of Results

The third danger point for scientists in their pursuit of 'sound science' is Interpretation of Results. It is a grave danger when the agricultural practice is invented by farmers in the field and not scientists in a laboratory. In these cases the practice is "Snake Oil" until proven otherwise. The possibility of the technique being commercialised is another black mark of suspicion against it. Pasture Cropping was invented by two farmers. One of them, Colin Seis of Gulgong, spent 10 years refining his technique for sowing by drilling cereal crops into dormant perennial pastures to maximise the productivity of the land. Just as Lodge., D., et al. sought to discredit grazing management by proving that all the graziers using it successfully were wrong, a similar exercise was conducted over Pasture Cropping. The research team made two mistakes: 1. The researchers accused the technique of a failure to perform tasks for which it was not designed. The yield from the crop is less in this system than in a straight cultivation and fallow. Col Sies has refined the technique to bring his yields up to equivalent to conventional harvests. The system is not recommended by Mr Seis if grain production is the primary objective. Yet the research report condemns it for being unfit for this purpose. 2. They accused the perennial pasture of robbing the crop of moisture when such native grasses are well-equipped for retaining moisture in soils.

There was no attempt to involve Col Seis in the process to explain

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[20] *Senior CSIRO soil scientist Jeff Baldock says there is today no technical barriers to a fully-functioning market in soil carbon, and that such a market could make it 'more economic to farm for carbon than to farm for yield.' (ABC Rural Radio, October 2007, Orange Field Days.)*

these issues and guide the methodology. Instead, the report in The Land Newspaper quoted a DPI District Agronomist and an agricultural consultant, neither of whom had any experience with the technique, but who both felt qualified to make negative judgements about it.

Tug-of-war

There is a cultural and political struggle going on in Agriculture today, a struggle for the hearts and minds of Australian farmers. between government science and extension services (provided by the CSIRO, the States' Departments of Primary Industries, Departments' of Agriculture, etc.) and private training and mentoring services (such as Holistic Management, Grazing For Profit, or Principal Focus, or Pasture Cropping, or Biological Farming, or Biodynamics, etc.) The essential difference between the two sides is not only government vs non-government, but also artificial vs natural. Whereas the Government extension officers are steeped in the tradition of "Industrial Agriculture" (synthetic fertilizers, herbcides and pesticides), the private operators rely on 'biomimicry' or 'natural' systems that 'mimic Mother Nature' to support what could be called "Natural Farming". The latter is referred to as "Snake Oil" and "Faith-based" by the defenders of "Sound Science".[21]

This battle has all the hallmarks of a major institutional slugging match. While designed to look like a sporadic, grassroots effort, the official "Pushback" campaign was well coordinated and funded.

Between paradigms

Science, which has given Humanity so many discoveries and

[21] *The Cotton Industry – known for high chemical input – reacted to the growing popularity of soil biology and natural soil nutrient management by accusing its 0rivate industry proponents (Dr Elaine Ingham, Dr Arden Anderson, etc.) as teaching 'faith-based' practices and of ridiculing science. (Cotton CRC internal memo, 2006) A report commissioned by the GRDC in 2005 found very high levels of interest in soil biology among growers. This is evidence of dissatisfaction with the chemical regimes recommended by government extension services traditionally. The CRC meeting minutes recommended that a "credible alternative" to Drs Ingham/Anderson be found and that growers be disabused of the delusions they have been sold (ie. that soil biology was important when the meeting participants agreed that "90% of soil management is chemical/physical" – a reflection of the levels of ignorance in official soil science. There followed a recital of the faith-based knowledge of the conventional: "Is there a link between soil biodiversity and productivity? (Answer: No) Is anhydrous ammonia a disaster? (Answer: No – soil organisms soon re-colonise the soil)." Such is the 'soundness' of "Scientific Fact".*

insights, also has within it structures that can suppress innovation that would benefit society. The reason: a medieval guild structure enforces group-think and fear of change. The control exercised by a ruling paradigm can blind scientists to datawhich contradicts that paradigm. Scientists, who believe their judgement is objective and value-free, can be found acting like politicians on the hustings to suppress a new paradigm.

Some scientists react to out-of-paradigm phenomena with anxiety and suspicion. The contrasting behaviour of scientists towards to different techniques of biosequestration (Biochar and soil carbon) ilustrates the point. Whenever a scientist refers to Biochar they rarely mention the many technical difficulties it has yet to resolve. However, when scientists refer to soil carbon it is usually followed by recital of a litany of difficulties, most of which are not material. Biochar is in paradigm. Soil carbon is not.

Thomas Kuhn, who coined the term 'dominant paradigm', explained that scientists live in self-policing communities that regulate their members by controlling entry to the field by censoring the content of their education and credentialling as well as controlling their output by the peer-review system.[22] The shared values and norms of the scientific community form a barrier to out-of-paradigm concepts. Kuhn says science aims to 'force nature into the preformed and relatively inflexible box that the paradigm supplies. No part of the aim of science is to call forth new sorts of phenomena; indeed those that will not fit the box are often not seen at all.' [23]

Some believe in the 'theory-laden observation' or rose coloured glasses. "Men who have excessive faith in their theories or in their ideas are not only poorly disposed to make discoveries but they also

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[22] "The study of paradigms... is what mainly prepares the student for membership in the particular scientific community with which he will later practice. Because he there joins men and women who learned the bases of their field from the same concrete models, his subsequent practice will seldom evoke overt disagreement over fundamentals. Men and women whose research is based on shared paradigms are committed to the same rules and standards for scientific practice. That commitment and the apparent consensus it produces are the prerequisites for normal science, ie. for the genesis and continuation of a particular research tradition." Kuhn, Thomas, 'The Structure of Scientific Revolutions', University Chicago Press, 1996 – See Appendix 6.

[23] See Appendix 7 - Presenting Data - Imposing A Pattern In Defence Of The Dominant Paradigm

make bad observations," wrote Pierre Duhem in 1906.[24] Instead of searching for the truth, these scientists search for evidence that proves they are right.

One of the founders of Quantum Physics, Werner Heisenberg, discovered that the mere presence of an observer caused particles to act differently. But the working scientist will tell you that real world science is conducted in a real world setting. Facts are facts. Day-to-day business of growing your career as a soil scientist doesn't allow for such niceties.

The naïve belief in black and white facts blinds the believers to the potentials of bias and allows some scientists and agronomists to commit acts of unprofessionalism.

"Scientific" Propaganda

The propaganda campaign against soil carbon's suitability to be traded by Australian farmers has been widespread and well-organised. It has been led by two premier research bodies: the CSIRO and the Grains Research & Development Corporation (GRDC). The campaign involved several instances of unsound science and the manufacture of 'scientific facts', unusual behaviour for such august bodies but a reflection of the level of anxiety felt in official circles.

The fact that there has been (and continues to be) a campaign was denied by the GRDC in a Senate Standing Committee hearing. The evidence in the Corporation's publishing record suggests otherwise. Six articles in the newspaper Ground Cover since July 2007 have focussed on a negative portrayal of the prospects for trading soil carbon offsets. A similar list of press releases carry the same messages. Seminar speakers were selected for their negative stance on the issue. And the GRDC is believed to have funded the "Soil Carbon Mythbusters" seminar series in three States which were aimed at undermining support for the soil carbon trading campaign.

Not one mention of the benefits of such trade or market-based incentives that could help farmers offset their emissions can be found throughout the entire output from the Corporation. The advice given to its constituents lacks balance, at the least.

The GRDC launched a "research paper" by Alan Umbers, Manager of the GRDC Farming Practices For Sustainability project on July 10th 2007. "Given the age and

[24] "They necessarily observe with a preconceived idea and when they have begun an experiment, they want to see in its results only a confirmation of their theory. Thus they distort observations and very often they neglect important facts because they go counter to their goal." Duhem, Pr. "The Aim and Structure of Physical Theory"

degraded nature of Australian cropping soils and the 'natural' low levels of organic carbon, there is no scientific evidence to suggest that there is a real possibility that organic carbon levels can be increased by cropping or farming practices at anything other than slow rates..."[25] Mr Umbers was toured around Australia, presenting the report's conclusions at events such as the GRDC-supported 2008 WA Agribusiness Crop Updates, (reported in May 2008) and appearing on ABC Rural Radio and in submissions to the Garnaut Inquiry. (Mr Umbers's statement is not supported by any scientist on record. Professor Alex McBratney says soil age has no bearing on its sequestration potential. Dr YN Chan says we can put back all the carbon lost, on average 25tonnes per hectare.)

But Alan Umbers was presented as a rogue operator, running his own campaign, according to the GRDC: "…that can be attributed to a fellow who was doing some consultancy work, which was tied to the GRDC, and that was probably taken out of context in the way in which he spoke. He spoke with his personal opinions at the time. I am referring to Alan Umbers, if that is the article you are referring to. It is certainly not the view of GRDC…" (Keith Perrett, Chair, GRDC)[26]

Mr Umbers has had carriage of the GRDC's Climate Change issues management, it seems, since the launch of the paper, and as late as April 2009 was actively engaged in the role. More than just 'some fellow doing consultancy work voicing his own opinions' Umbers is the most senior executive with carriage of Climate Change issues within GRDC and his comments reflect the opinions expressed in every public communication on the matter issued by the Corporation. He is currently (June 2010) Acting Executive Officer of the Grains Council of Australia.

Models Unreliable

The opposition to the contention that Australian soils can sequester significant amounts of Carbon – and quickly – rests on 'models' that contain the data produced by scientists to date: data from conventional land management and some low-intensity techniqes like minimum tillage and no-tillage.

When the government asks scientists about the potential of our soils, the scientists consult the

[25] "Carbon in Australian Cropping Soils: A background paper prepared by Alan Umbers For the Grains Council of Australia." July 10th 2007

[26] STANDING COMMITTEE ON RURAL AND REGIONAL AFFAIRS AND TRANSPORT, AGRICULTURE, FISHERIES AND FORESTRY PORTFOLIO - Grains Research and Development Corporation (GRDC) Senate-Monday, 20 October 2008

models – and give the only answer they can give: the potential for change in soil Carbon is for small amounts over long periods. But the accuracy of these models has been questioned by a senior government scientist. Dr Peter Fisher of the Victorian Department of Primary Industries found that Australian soils can sequester carbon 6 to 10 times faster than the models allow.[27] The models have for a long time been questioned by practitioners whose reults contradict the peer-reviewed data. Dr Fisher explains: "Modelling also suggests that under many Australian circumstances it may be impossible to increase TOC levels in agricultural soils, although this is in contrast to an increasing number of growers who are claiming to have made substantial improvements in SOM in relatively short time periods. … Some of these differences may be due to comparisons between modelling results based on typical practices and results, compared with individual growers whose management practices are atypical and well above those of the district norm. However, there is a need for much greater evaluation of both the claims made by growers and the assumptions that underlie modelling results."

A series of articles in the Australia Farm Journal call into question the usefulness of the Roth C model (in its current configuration) for predicting the soil C performance of soil. It ignores the contribution of microbial communities. The articles take a long look at "The hidden costs of soil carbon" - a short paper by 5 CSIRO scientists which 'proved' that landholders could not afford to grow humus because of the cost of Nitrogen, Phosphorous and Sulphur inputs. The paper was based on a premise that is widely believed in soil science community: that the carbon sequestration potential of a soil is limited to the amount of organic matter added, ie. stubble retained, manure spread "The current configuration of a soil carbon model called Roth C suggests there would need to be 20 to 30 tonnes/ha/yr of biomass input to achieve the higher carbon sequestration rates we have measured under some perennial grasses in the Northern Ag Region of WA.," says Tim Wiley from the Department of Agriculture & Food, WA. But, while putting on an additional 16 tonnes of soil carbon/ha under perennials (vs

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[27] *Dr Fisher is saying the modelling suggests a 2t/ha increase in organic matter input for the same conditions, results in a change in soil carbon value of about 0.13pc after 20 years. However his research indicates that a 2t/ha increase in soil organic matter might result in approximately a 0.4pc change after only 10 years. Now 0.4pc is 3 times as much as 0.13pc, and 10 years is twice as quick as 20 years - so this is still a factor of 6 times better. And this on places where the farmers were not even focussed on building soil carbon.*"

annuals), the measurements of above ground biomass have been only 10 tonnes/ha/yr. Had the hypothesis of the CSIRO paper been right, there should have been a shortage of plant available Phosphorous under the perennials, with the extra tonnes of carbon sequestered binding more than 300kg/ha. But plant available P increased by 43kg/ha. This increase in P was also experienced by Scott Macalman at Warren.

The CSIRO Paper is misleading. Yet it was sent to 37,000 growers by the GRDC as part of its sustained campaign against the idea that farmers could ever be paid for growing soil carbon. The paper reveals that the analysis did not take into account the emerging knowledge of soil microbiology. It assumed that there could be no other source of nutrients than a bag from a fertilizer company. The formula for humus means you need 60kg of N, 12kg of P and 9kg of S for every tonne of humus you make. One of the paper's authors used this additional nutrient requirement to call into doubt Col Seis's 2% increase in soil carbon over 10 years.

It is out a paradigm at present, but soil biology is becoming popular inside both CSIRO and GRDC. Free-living nitrogen-fixing bacteria and symbiotic fungi can release and make available to plants vast amounts of the N, P, and S locked up in the soil after years of over-application of fertilisers. A CSIRO Fact Sheet says: "We know the current amount of nitrogen fertilizer applied per year is about 100 Megatons of nitrogen. However, we do not have an accurate knowledge of the amount of nitrogen addition through nitrogen fixation, although estimates are between 50 and 200 Megatons of nitrogen per year."[28] A NSW Department of Primary Industries fact sheet says, "Rhizobium bacteria ... can fix 100kg of nitrogen per hectare per year."[29]

In 1998, a CSIRO team claimed that Australian agricultural soils may be holding up to $10 billion worth of phosphorus, as a result of fertiliser applications. "The rural industry spends $600 million each year on phosphate-based fertilisers, yet often only about 10 to 20 per cent of the phosphorus is directly used by plants in the year it is applied," said CSIRO Plant Industry researchers Dr Alan Richardson and Dr Peter Hocking[30]. "The remaining phosphorus becomes locked-up in the soil," he said.

If the right bacteria and fungi are present, more nutrient means more growth, which means more microbial activity and more biomass to enrich the soil. "When

[28]http://www.csiro.au/resources/GlobalNitrogenFixation.html

[29]http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/41639/Microbes_and_minerals.pdf

[30]http://www.csiro.au/files/mediaRelease/mr1998/Raiding10BillionPhosphorusBank.htm

phosphorus is scarce in soil, plants that have developed mycorrhizas on their root systems have greater access to and take up more phosphorous than others," according to the University of Western Australia's Soil Science Department.[31]

The belief that only by introducing organic matter from outside the system can organic carbon grow seems to dominate thinking in high places. But wasn't this idea superseded long ago? “Numerous studies have shown that the introduction of strains of [bacteria] into the rhizospheres of cultivated plants led to significant increases in grain yield as well as total dry matter... The stimulations observed are most likely due to the production of growth hormones by these bacteria."[32]

Free Nitrogen

Soil organic matter (SOM) can supply much of a farmer’s Nitrogen needs. “In cropping systems, as much as 50%-80% of the N can be supplied from SOM and nearly 100% of the N in native ecosystems,” writes Professor Charlie Rice in his book Soil Carbon Management. This percentage represents 11-300kg N ha-1 for a crop.[33] Nitrogen, like Carbon, is mobile. It cycles. Most N in soils comes from the air and is absorbed by micro-organisms associated with legume plants. N is fixed by legumes and stored in the soil in organic forms, to be broken down by other microbes – via two processes: mineralisation and nitrification, via which it is transformed into ammonium and nitrate.[34]

Former NSW Department of Agriculture agronomist Adam Wilson told The Land that the best way to build up a N bank is to add carbon to soils. Management that builds C also builds organic N because both processes rely upon interactions between rootmass and microbes. He recommends adding organic carbon via composts, green manures or planned grazing, avoiding highly alkaline fertilizers which burn up C and humus, minimum tillage, and a legume or pasture rotation

Potential of Australian Soils to Sequester Carbon

Three recently reported case studies reveal significant increases in soil carbon are possible in Australian soils: Cam McKellar, “Inverary Downs”, Spring Ridge NSW: An

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31 http://www.soilhealth.segs.uwa.edu.au/components/fungi

32 Davet, Pierrre, Microbial Ecology of the Soil and Plant Growth, 2004

33 Smith, J.L., Papendick, R.I., Bezdicek, D.F., and Lynch, J.M., Soil organic matter dynamics and crop residue management, in Soil Microbial Ecology, Metting, F.B., Jr., Editor, Marcel dekker, Inc., New York, 1993, pp65-94.

34 Charman, P.E.V., Soil Nutrient Decline in Charman, P.E.V. & Murphy, B.W., Soils: Their Properties and Management, Oxford U Press, 2000

increase of 0.59% SOC between March and November, 2008 in a cropping enterprise.[35]

Brian Kreig, "Kreigfields" Snowtown SA: An increase in SOC of 1.17% in 3 years in a broadacre cropping environment.[36]

Michael, Noel and Marie Moretti, "Roselea" Biloela QLD:An increase of 0.57% SOC in pasture cropping environment.[37]

An increase in soul carbon was recorded on grazing and cropping land from 2% to 4% recorded on "Winona", Gulgong, between 1995 and 2005.

Dr K Yin Chan, Principal Research Scientist (Soils), NSW Department of Primary Industries, has a research project which has stretched over 20 years. In the soils studied, he found that there was on average 70 tonnes of soil carbon per hectare under undisturbed native vegetation. This fell dramatically to 40 T/ha under conventional tillage by the 1940s. It rose 5T/ha under Reduced Tillage, to 45T/ha. Dr Chan believes we can recover the (25T/ha) balance. He calls it the "Soil C Sequestration Potential".

"Permanent unimproved pastures in moister areas of NSW, SA, WA and Qld, after sowing to introduced grasses and legumes and fertilised with superphosphate have been shown to exhibit linear increases in soil C at a rate of about 0.4 t C ha^{-1} yr^{-1} over several decades.[38]

Barrow (1969) reported a soil C gain of 440 kg/ha/yr in sandy soils under permanent pasture during a period of 30-40 years in Western Australia. The pasture outscored undisturbed native vegetation on soil C by 2.0% to 0.8%.[39]

[35] Australian Farm Journal, May 2010

[36] LaurieCo Biological Farming Systems Soil Carbon Tour Handbook, May 2010

[37] Australian Farm Journal, April 2010

[38] *Gifford RM, Cheney NP, Noble JC, Russell JS, Wellington AB and ZamitC (1992) Australian land use, primary production of vegetation and carbon pools in relation to atmospheric carbon dioxide concentration. pp151-187 in Australia's Renewable Resources, Sustainability and Global Change. Roger M. Gifford and Michele M. Barson (Eds) Publ Bureau of Rural Resources and CSIRO Division of Plant Industry. Quoted in "Pasture improvement for potential additional C-sinks for inclusion under the Kyoto Protocol", by Roger M. Gifford, Damian J. Barrett and Andrew Ash for the Biosphere Working Group of the CSIRO Climate Change Research Program, 30 April, 1998b*

[39] *Barrow, N. J. 1969. The accumulation of soil organic matter under pasture and its effect on soil properties. Australian Journal of Experimental Agriculture and Animal Husbandry 9:437-445f.*

Science Lagging Practice

When a highly respected scientist such as Dr YN Chan produces a report[40] which says we can't sequester carbon except by using traditional fertiliser, Science has a problem. Farmers who are growing carbon in their soils know these results are wrong. Scientists we speak to are surprised at the results. But Science has never been able to justify any land management approach that it did not originate: eg. planned grazing or pasture cropping or zero tillage. To find for the petrochemical companies and against grass-roots-developed natural systems has caused some cynical remarks.

Dr Yin Chan is always careful to be scientifically correct whenever he discusses his results. Not so the 'communications' experts massaging the media. The Doctor says of his investigation, that no statistical difference was found for all options except pastures improved with phosphate fertiliser. He doesn't discount the possibility that other options could have an effect. He says the methodology – paired paddock comparisons - and the 'field variability' in samples could easily have 'masked' any differences.

But in the Booklet which reports the results, the headline reads "Pasture types do not affect SOC" which is very different to the text beneath: "We found no significant differences in SOC stocks between introduced or native pastures, and between annual and perennial pastures."

This study had two "findings" reports – an interim report released in July 2009 and the elaborate Booklet "A Farmer's Guide…" last month.

To judge by the tone of the ABC Rural report, the direction of the spin: "The latest science has debunked theories that rotational grazing methods can dramatically improve carbon storage in your soil. Dr Yin Chan of the NSW Department of Primary Industries says they compared carbon sequestration under set stock grazing compared to rotational grazing, native versus introduced pastures, and perennial versus annual plants. Dr Yin says none of those methods increased the amount of carbon taken up by soil in paddocks. He says adding phosphorous fertiliser was the only significant way to improve pasture production and soil carbon."

He said no such thing. He was carefull to say: "Actually after we got all the data and compared them statistically there's only one treatment we can find a statistical difference and that's due to P fertilisers," says Dr Yin Chan.

Dr Chan was not 'debunking' anything.

[40] * Chan, YN, Oates, A., Lui, DL., Li, GD., Prangnell, R., Poile, G., and Conyers, MK. (2010). "A farmer's guide to increasing soil organic carbon under pastures", NSW Industry & Investment, Wagga Wagga, NSW

Biofertilisers next victim?

Meat & Livestock Australia (MLA) is performing scientific trials on biological fertilisers. But the language used to report the project indicates that the outcome could be predictable. The story starts with the blanket statement; "Australian farmers have always prided themselves on innovation but when it comes to alternative fertilisers, they're justifiably wary." Bioferts are considered dangerous by the scientists conducting the eight Producer Sites across southern Australia. Soil scientist Jeff Hirth is quoted as saying that "many farmers fall under the spell of clever marketing by alternative fertiliser products." Holbrook grazier Ian Locke also prejudges the outcome, saying, "It would be difficult to be a profitable low input production system." The MLA Research Adoption Manager Jane Weatherley felt confident enough of the outcome to make the sweeping statement: "Farmers want optimum beef production out of their land and not all the products on the market can enable that." WE predict that none of the alternative products will be validated by science and the reason will be seen in the methodology. Products in the trials include TM21, Nutrisoil LS, CalSap, Bactivate, Prolong, RUM and single super at 123KG/HA. (Feedback, May 2010)

Gap growing wider

More than a decade ago a soil scientist declared that the gap between science and farmers was widening. Professor Ben Norton identified this 'impasse' between graziers and researchers in the McClymont Lecture[41] in 1998: "The results of grazing trials have been counter-intuitive... Based on scientific research, [we] can only recommend continuous grazing and reduced stocking rates..." [to increase pasture biomass]. Science, based on 'hundreds of studies' concluded that planned grazing is not cost effective. This would be embarrassing if one study reported it, but the entire research community? Professor Norton observed that "graziers are looking elsewhere for advice". How many graziers today use some form of stock movement to manage their pasture? The emergence of farmer groups to drive their own research agendas and control their own destinies has paralleled the rise in biological agriculture.

When all that you have in your hand is a hammer, everything looks like a nail.

[41] Norton, BE., "The application of grazing management to increase sustainable livestock production," Animal Production In Australia, Vol. 22 1998. Ben Norton is a Professor in the Department of Rangeland Resources at Utah State University.

Academics Hysterical

More recently, the Australian Council of Deans of Agriculture became infected with the hysteria noted above, when it launched an attack on the makers of biological fertilizers, claiming "some" of them "could" be endangering Australia's export trade by introducing contaminants into the food chain. President of the Council, Peter Roush, abandons the need for evidence – "we don't know what's going into those products" – before drawing a conclusion – ""It's doubtful that there's any efficacy for [them]".[42] A brave biofert maker would submit to these scientists.

Anti Trading Scientist

It is easy to spot an anti-soil C trading scientist. They harp on about complexity, find lots of it, and make no attempt to simplify. They are so transparently fixed. Even their language in scientific papers is political. Here is an extreme example from a 2009 CSIRO paper: "The existence of the above and other real-life complexities will render market-based C-trading schemes involving pastures, exposed to the risks of complicated, ill-conceived, ill-understood, poorly regulated financial instruments and arrangements that are replete with opportunity for fraudulent scams and inappropriate diversion of community wealth to the personal fortunes of scheme managers and traders, while not delivering the scheme objectives, reminiscent of those involved in the Global Financial Crisis of 2007-2009."[43]

Farmers lead

Labor MP Dick Adams, who chaired the House of Representatives standing committee on primary industries looking at methods being adopted to help reduce agricultural emissions and the impacts of climate change on farming, said farmers had been trialling methods to adapt to the changing climate for years and were sometimes ahead of the scientists."We weren't having esoteric discussions about what causes what (change) in the climate," he said. "We were seeing people at a very cutting edge stage, dealing with these variabilities in climate. They are well ahead in many cases, of the researchers."

Official science is still stumbling along behind, "proving" that no-till and planned grazing and pasture cropping don't work. This pattern of denial has become embarrassing and was mentioned by Member for

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42 *"Academics lash out at 'wild west' farm products" The Country Hour, ABC Radio, ABC Online, 24/11/2010*

[43] See Appendix 4.

New England Tony Windsor MP and the Australian Farm Journal in recent weeks. The Productivity Commission Inquiry into Rural Research & Development Agencies has put the question: "How effective is the current rural R&D and extension framework, and is the role of the RDCs within that framework appropriate and clearly defined?" Has there been anything useful for farmers and the broader community in the torrent of negativity pouring out of esteemed research institutions on the prospects of increasing soil carbon levels? Any new ideas?

"Innovative farmers are in front of the researchers," says Tony Windsor, Member for New England, who was on the sub-committee chaired by Mr Adams. In the area of bio-dynamic and biological farming practices, many farmers are experimenting way ahead of the research currently available. "There's a lot of history in that. In the adoption to no-till farming and conservation farming, it was farmers leading the debate. The researchers eventually caught up."

Patrick Francis, editor of Australian Farm Journal, declares in the April 2010 issue that "mainstream science is struggling to embrace opportunities for adaptation, preferring to lobby for more research." He quotes from the new CSIRO book Adapting Agriculture to Climate Change. The authors of the chapter on grazing wrote this revealing statement: "The adaptation challenge and opportunity need to be clearly defined by quantifying the range of plausible impacts that uncertain climate change could have on the grazing industry and framing adaptation options in relation to existing management pressures. Likely responses of grazier and policy-makers to these impacts need to be determined and comprehensively evaluated." Put aside the astonishing lack of urgency..

The CSIRO and their colleagues in other institutions have been acting as though climate variability is a new phenomenon. But a 2004 study by the QLD Dept of Natural Resources identified 8 'pasture degradation' episodes since 1788. The main factor in degradation was poor stock management. Too many animals left on the pasture too long. (“Pasture Degradation and Recovery in Australia’s Rangelands”) Patrick quotes a 2009 FAO paper "Review of evidence on drylands pastoral systems and climate change" which is optimistic about grazing management and soil carbon in pastures. He quotes the CSIRO making the obligatory negative statement: "Efforts to sequester carbon in rangelands will also have to be carefully considered against the long-term costs and benefits of maintaining the enhanced vegetation and soil carbon stores often in face of climate changes

which tend to reduce them."
What must be discouraging for these 'concerned' scientists is the rapid uptake of the practices they prove to be ineffectual by their research trials. No-till is reaching saturation in several states.[44] Col Seis – the inventor of Pasture Cropping – is having trouble keeping up with demand since a nasty attack on him and his techniques by NSW Industry & Investment..
The CSIRO's contribution to the soil carbon trading cause has been the "You Can't Afford to Grow Humus" campaign with the GRDC and "The Bucket of Biomass Limitations" Theory[45]. And the "Soil Carbon Mythbusters" campaign with NSW I&I. It has always been consistently negative. Now it is being noticed.

Appendix 1: GRDC on the Potential of Australian Soils to Sequester Carbon:

The GRDC has been the source of many statements about soil carbon:

STATEMENT: "Any suggestion that farmers can increase soil carbon to levels of 3% or greater fails to understand that soil carbon is part of the carbon cycle, and heavily dependant on plant growth, soil microbial activity and seasonal conditions." (Alan Umbers, GRDC - Research Update - Carbon in Australian cropping soils [16 August 2007)

FACT: A typical carbon score for a paddock in the cropping/grazing zones on the slopes in the Central West of NSW is 1.5%. According to Dr YN Chan (Principal Research Scientist (Soils) NSWDPI and global top 10 scholar by references to his papers by other scientists) we have lost more than half the carbon the soils held originally and that farmers can replace that amount and possibly more.[46] This would make 3% achievable.

STATEMENT: "Our soils are very old, very fragile, very thin, very weathered. Often we are running spoils with 1% or less carbon." (Alan Umbers, ABCRadio Country Hour, 11 July, 2007)

FACT: Generalisations about Australians soils are dangerous. Alpine soils contain around 10% soil carbon, and desert soils around 0.5%. Soils tested for soils workshops with farmers at Mudgee and Rylstone have between 0.9% and 7% Carbon and averaging

[44] NSW penetration recently reported as 68%. WA and SA led the charge, with WA now in the 90% region.
[45] See Appendix 3.
[46] Dr Yin Chan, "Increasing soil organic carbon of agricultural land", NSW Department of Primary Industry PRIMEFACT 735 JANUARY 2008

2.2% at Mudgee and 2.7% at Rylstone.[47]

STATEMENT: "Given the age and degraded nature of Australian cropping soils and the 'natural' low levels of organic carbon, there is no scientific evidence to suggest that there is a real possibility that organic carbon levels can be increased by cropping or farming practices at anything other than slow rates, reaching an equilibrium point well below that of northern hemisphere soils." (Alan Umbers, GRDC - Research Update - Carbon in Australian cropping soils [16 August 2007)

FACT: There is no scientific evidence that age, nature or low levels of carbon can determine how fast carbon can be sequestered. There is considerable scientific opinion to the contrary: Sydney University Professor Alex McBratney said: "While it is true that much of Australia's soil cover is on old landscapes this in itself does not preclude reasonable levels of soil carbon. It's misleading to say that because Australia has old soils there isn't potential for enhanced sequestration of carbon in our soils." - Alex. McBratney is Pro-Dean, Professor of Soil Science, Faculty of Agriculture, Food & Natural Resources, The University of Sydney.

FACT: Comparing Australian soils unfavourably with soils found in the Northern Hemisphere reveals poor knowledge of European and North American soils – eg. the least of Australia's soils have their counterparts in parts of Spain and America such as New Mexico.

STATEMENT: "Importantly, upon reaching any new or higher carbon equilibrium, these soils will require continued inputs of organic carbon at high levels just to remain at an elevated organic carbon level. This may lead to the areas involved becoming 'uneconomic' as farm land, as the cropping and grazing systems would have to be dramatically altered to retain the levels of organic matter needed to sustain higher soil carbon levels." (Alan Umbers, GRDC - Research Update - Carbon in Australian cropping soils [16 August 2007)

FACT: A common mistake is to overlook one critical factor in the sequestration process: there has to have been a change in land management that led to the additional carbon being sequestered. "Business as usual" is not considered under Kyoto. This factor renders all the case studies used by our critics irrelevant. [Article 3.4, KYOTO PROTOCOL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE specifies "additional human-induced activities ". Intergovernmental Panel on

[47] John Lawrie, Soil Officer, Central West Catchment Management Authority.

Climate Change, "Land Use, Land-Use Change and Forestry" speciies: "Change in management within a land use or change in land use to one with a higher potential carbon stock can increase carbon stocks in an ecosystem, leading to a net removal of CO2 from the atmosphere."
http://www.grida.no/climate/ipcc/land_use/157.htm]

FACT: Non-man-made impacts on emissions from land are currently counted against any nation which includes soil sequestration in its accounts, under Article 3.4. The Australian Government, the FAO, the EU, the USA, and the International Federation of Agricultural Producers have all lobbied under the Copenhagen round of negotiations to have non-anthropogenic sources of emissions from land (drought, bushfire) excluded.

STATEMENT: "Changed circumstances on farm, such as drought, changed tillage system, crop types and rotations, pasture management and fertiliser practices can all have serious effects on levels of soil carbon." (Alan Umbers, GRDC - Research Update - Carbon in Australian cropping soils [16 August 2007)

STATEMENT: "Farmers involved in producing grain are generally net emitters of greenhouse gasses through the use of fossil fuels and fertiliser." (Alan Umbers, GRDC - Research Update - Carbon in Australian cropping soils [16 August 2007)

FACT: Farmers entering into contacts to trade soil carbon commit to a change in land management for the period of the contract. This is the basis for the Chicago Climate Exchange model and variants. The farmer is expected to change from practices that emit Greenhouse Gases to those that avoid emissions and which tend to sequester carbon in soil. So "changed tillage system, crop types and rotations, pasture management and fertiliser practices" are prescribed in the contract. (Prime Carbon Soil Carbon Sequestration Protocols)

FACT: This statement is true only for 'business as usual'. Not for changed land management required to sequester soil carbon. There are many farmers in the Carbon Coalition who have reduced emissions to below their sequestration rates.

STATEMENT: "The limited potential for Australian soils to increase levels of organic carbon, with estimates by many scientists of less than 100kg per hectare per year, even under the most effective non irrigated farming systems." (ibid)

CORRECTION: No properly funded research has studied the "potential" of Australian soils to take up carbon under Best Practice Management. Most official studies recorded poor carbon performance because they studied only traditional techniques which are destructive of soil carbon. There were no advanced farming practices – such as time controlled grazing, pasture cropping, biological farming – included in the official studies.

STATEMENT: "You can lift soil carbon 0.001% a year if you're lucky." (GRDC Manager Alan Umbers, ABC Radio Country Hour, 11 July, 2007)

CORRECTION: This statement is based on out-of-date data. Cases that are in the pipeline for reporting to the AGO include the following: 1. Pasture cropping/time controlled grazing combination in Central West NSW that has recorded a 100% increase in soil carbon to 4% over a decade, with most of the growth in the last few years. 2. A till-to-no-till case in Albany, WA where an increase from 4% to 6% was achieved in 3 years. 3. A 20 year study of till-to-no-till techniques at Wagga NSW recorded a gain of 12 tonnes of carbon per hectare, or 0.6% per year.

GRAINS COUNCIL
ASSERTION: "Normal farming practices emit greenhouse gasses such as carbon dioxide and nitrous oxide, with the latter having a global warming potential equal to 310 times that of CO2."

CORRECTION:"Normal farming practices" are no guide to the potential of land management to make a difference. "Carbon Farming Practices" reduce emissions of CO2 and NO2 and enable the farmer to 'grow' carbon to offset their emissions.

GRAINS COUNCIL
ASSERTION: "Any carbon trading scheme will require farmers to show that increased organic carbon will have to remain permanently in the soil for up to 70 or more years"

CORRECTION: The 100 Year Rule applies to forests. But on the biggest carbon exchange trading farm soils – the Chicago Climate Exchange - soil carbon is traded in renewable four year contracts.

GRAINS COUNCIL
ASSERTION: "Drought or changed farming techniques may cause carbon to be released to the atmosphere and this is an important factor to consider while balancing grain production emissions with any carbon sequestration."

CORRECTION: Carbon Farming techniques actually increase the soil's ability to hold and use available water better than

traditional techniques. However severe drought is a reality and carbon trading contracts include insurances and make good provisions, like any other contract.

GRDC ASSERTION: "Any carbon trading scheme will involve enforceable contracts and auditing of farms. This will increase costs for farmers, possibly outweighing any financial benefits."

CORRECTION: The Chicago Climate Exchange arrangements set aside 30% of the trade value for aggregation of growers into 25,000 acre trading units, auditing, administration, etc. Farmers in the US don't seem to mind. Total volume traded to date on the CCX is 2.7 million tonnes.

ASSERTION: "More accurate measuring of carbon sequestration and greenhouse gas emissions will need to be developed."

CORRECTION: The AGO has already spent millions developing emissions calculators. The technology exists. It is time to populate the calculators with data. What's the hold-up?

GRDC ASSERTION: "Farmers need to be cautious about any attractive sounding claims about the income earning potential from future carbon trading schemes. These will have significant transaction and verification costs, involve long term contracts, be enforceable and auditable, and may not end up paying more than a few dollars per hectare". Mr Umbers said.

CORRECTION: "Farmers need to be cautious about anything they hear about trading carbon, especially from the ill-informed who have studied the market by relying on official research that was never designed to support the claims made by by standers.

STATEMENT: "W hile there are factual aspects to much of this information, it would seem sometimes it gets extrapolated a bit too far, possibly for individual or commercial gain." [48] A GRDC-

[48] Kondinin Group Exploding soil carbon myths, Farming Ahead, Tuesday, 02 September 2008
http://www.farmingahead.com.au/ViewArticle.aspx?ID=6152
Western Australia's Grower Group Alliance (GGA) presents the 2008 Researcher Roadshow, hosting Clive Kirkby from CSIRO Canberra.
Supported by South Coast NRM Inc, Mr Kirkby will present 'Carbon Mythbusters: Exploding soil carbon myths in WA' at two grower group field days in the northern agricultural region and three on the south coast and present at two agribusiness breakfast in Perth and Geraldton.
GGA project leader Tracey Gianatti said: "The

funded seminar series promotional item in Kondinin Group newsletter, 2.9.2008

COMMENT: The following is an example of the 'optical illusion' that many conventional scientists fall into when considering the claims of Carbon Farmers about sequestration rates. They start with a belief in a small amount of carbon per hectare. But the calculation must step up the value twice: First from Carbon to Carbon Dioxide Equivalent, a multiplication exercise:

C x 3.67 = CO2-e.

The second calculation is also a multiplication, from one hectare to the total area:

CO2-e/ha/yr x Total ha = Total CO2-e/yr.

When 0.15C/ha can become 27,500tCO-e, no wonder scientists cry foul. But if they want to take part in a conversation which is not strictly scientific, they must observe the language of the discussion and respect the rules.

If we take a small increase of 0.15tonnes Carbon/h/yr over half the area used for Agriculture in Australia (225m ha) we shall see if soil, which already has Critical Mass, can also have Massive Capability:

0.15tC/ha x 3.67 = 0.5505tCO2-e

225m ha x 0.5505tCO2-e = 123.8mtCO2-e.

The represents about a quarter of Australian emissions per year.

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presentations will increase participants' knowledge of, and 'explode the myths' surrounding the role of soil carbon; its impact on soil fertility, crop productivity and water holding capacity; the potential for soil to sequester carbon and methods to increase soil carbon." Project partner Wayne Pluske, of Nutrient Management Systems, said there was a large amount of information being presented to farmers on possible benefits of soil carbon, such as how it may increase water holding capacity of soils or suddenly increase plant-available nutrients. "While there are factual aspects to much of this information, it would seem sometimes it gets extrapolated a bit too far, possibly for individual or commercial gain."

Appendix 2 – GRDC Consistent Opposition

The GRDC managed to insert a negative story about soil carbon

trading in every second edition of its newsletter.

Carbon Sequestration – Caution Needed - July 10th 2007
The Grains Council of Australia says that Australian grain producers … are unlikely to benefit from a carbon credit or trading scheme, due to the low carbon sequestration potential of most of the soils in grain producing areas. The Manager of the Grains Council / GRDC 'Farming Practices for Sustainability' project, Alan Umbers, said carbon in soils was a complex and easily misunderstood subject.

Ground Cover Issue 70 - September - October 200
27.08.07 Soil Carbon - Carbon study shifts focus to nitrogen
Sequestering carbon, by reducing tillage, to participate in carbon-trading schemes would provide relatively small returns for Australian graingrowers, modelling research has shown.

Ground Cover Issue 70 - September - October 2007
27.08.07 Soil Carbon - Carbon trading brought down to earth
Graingrowers need to be realistic about the opportunities and risks presented by carbon trading, says Dr Michael Robinson, Land and Water Australia executive director and former CEO of the Cooperative Research Centre for Greenhouse Accounting. Dr Robinson echoed an overriding sentiment that soil carbon sequestration was unlikely to play a large role in carbon trading schemes.

Ground Cover Issue 75 - July - August 2008
01.07.08 Popular carbon needs clear intentions
Carbon is a popular topic lately – but should the focus be soil improvement or commercial sequestering in a future carbon trade? The options for Mallee growers

Ground Cover Issue 76 - September - October 2008
01.09.08 The hidden costs of carbon sequestration
…this estimated value could easily be out by a factor of two. Nevertheless, it casts considerable doubt on the viability of carbon trading schemes based on humus, the stable fraction of soil organic matter.

Ground Cover Issue 77 - November - December 2008
Doubts linger over tradeability of stored soil carbon
The workshop concluded that the grains industry could sequester more carbon, but prospects are limited by rainfall (there is more scope in higher-rainfall zones).

Ground Cover Issue 80 - May - June 2009
01.05.09 Carbon trading scheme explained

So carbon sequestration (or building organic matter) in agricultural soils under normal production systems is still going to be about its agronomic benefits, rather than any major windfall gains from the scheme.

Big Bucks From Carbon Sequestration - Fact or Fiction? (West, 27 February 2009)
With carbon credits in the news and Australia developing policies to meet its Kyoto targets, many farmers are intrigued by soil carbon's potential to not only boost soil productivity but put money in the bank by selling carbon credits. But just how realistic is that goal?
Dr Jeff Baldock of CSIRO Land and Water, SA, will address this and other aspects of soil carbon in the Grains Research and Development Corporation (GRDC) supported WA Agribusiness Crop Updates at Burswood Entertainment Complex, February 24 and 25.
Crop Updates are co-ordinated by the Department of Agriculture and Food WA (DAFWA) and Dr Baldock is being sponsored by the GRDC.

Dr Baldock will examine the functions of organic carbon and organic matter in soils, including its chemical, physical and biological properties. He will also discuss calculating changes in soil organic carbon content, including using simulation models to predict the outcomes of management practices on soil carbon content.
Carbon Accounting a Work in Progress (National, 11 November 2008)
Agriculture won't be in the Carbon Pollution Reduction Scheme until at least 2015, but it was much discussed at a GRDC workshop about on-farm carbon accounting.
Dr Martin Blumenthal, GRDC Manager, Agronomy, Soils and Environment, said workshop participants saw the need for a common terminology and agreed protocols for measuring and analysing carbon given the climate of uncertainty.
"Better data on farms' greenhouse emissions is needed and different accounting methods should be piloted and assessed," Dr Blumenthal said. "Whatever the carbon trading implications, increasing soil carbon makes sense in its own right. "Carbon credits are like FlyBuy Points – a nice bonus, but don't go shopping just to get them," he said.

The workshop proceedings are available by visiting the GRDC website at www.grdc.com.au and using the search 'carbon workshop'.

GRDC Code: PR160 Carbon Counts (West, 19 March 2008)
At the recent GRDC and DAFWA suppoted 2008 WA Agribusiness Crop Updates, consultant to the GRDC Farming Practices Initiative, Alan Umbers said that

Australian rainfed cropping soils were generally low in carbon.
Organic carbon comprised about one per cent of the top 10 centimetres of soil and was often lower in many areas, for example the mallee and sandplain soils of WA. Mr Umbers said that to increase soil carbon to levels of three per cent or more, for example, would require the annual addition of significant amounts of organic matter.
"From my research, it seems that only in zones where rainfall exceeds 550 millimetres and there is high biomass production, is there potential to increase soil carbon through conservation farming practices," he said.
Even with growers using best practice, rates of sequestration would be slow, taking perhaps 20 to 30 years to reach a new equilibrium.
For further information, see Research Update - Carbon in Australian Cropping Soils http://www.grdc.com.au/director/events/researchupdates?pageNumber=3

Times of Change on the Climate Front (National, 2 May 2008)
As time passes, language evolves to accommodate new words and phrases to describe new developments and situations. Phrases such as carbon sequestration, greenhouse gas (GHG) emissions and carbon trading are a few that come to mind and are now used to discuss climate change and its influence on the agricultural sector.
Carbon in Australian cropping soils, which are naturally dynamic and cyclical, is increased by inputs of organic matter and is highly dependent on plant growth, soil microbial activity and seasonal conditions.
Total soil carbon is affected by farming practices and natural events such as drought or heavy rainfall. Drought, for example, causes carbon loss through soil surface exposure and lowered inputs from biomass.
The Australian agricultural sector in general and grains industry in particular, are net emitters of GHGs.
Worth noting is that emissions have decreased markedly in recent years with reduced tillage and fuel use and better nitrogen fertiliser management.
A paper presented by Alan Umbers of the GRDC Farming Practices Initiative at the GRDC-supported 2008 WA Agribusiness Crop Updates, provided a 'big-picture' view of soil carbon from soil element to tradable commodity.
Australian rainfed cropping soils are generally low in carbon – frequently about one per cent in the top 10 centimetres.
Significant amounts of organic matter must be annually added to increase soil organic carbon substantially above these levels.
However, sequestration of soil carbon is not infinite – a new equilibrium level is reached after

perhaps 20 to 30 years – based on the cyclical nature of carbon, where farming practices and systems determine the balance.

Understanding soil carbon dynamics and the other greenhouse gas of interest, nitrous oxide, is difficult in a biological system such as grain production.

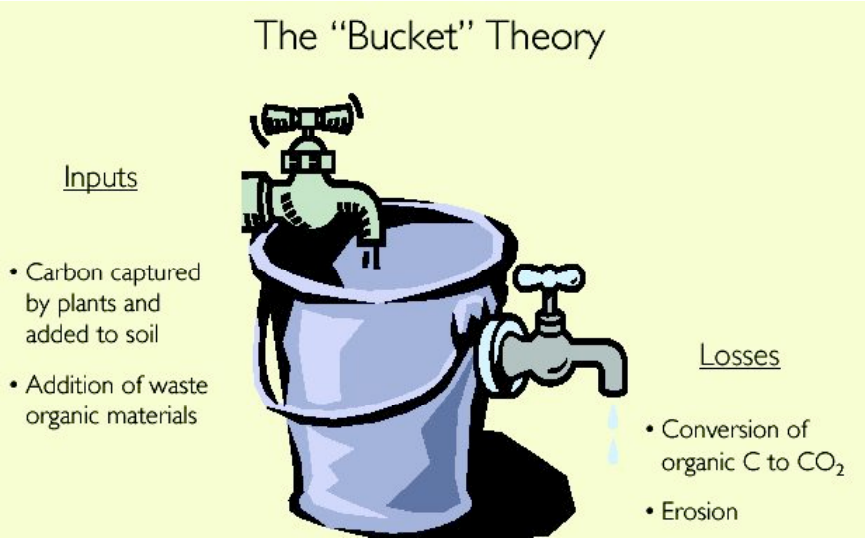
According to Mr Umbers' research, where there is high biomass production, perennials in the system and more than 550 millimetres of annual rainfall, soil carbon can increase with conservation farming practices. Most of Australia's grain crops are in drier areas.

Finally, he cautions growers interested in carbon trading schemes, as emissions and sequestration will be considered and participants may need contracts to verify their sequestration and emission levels.

Appendix 3: The Bucket Theory[49]

The Bucket Theory of Soil Carbon Sequestration holds that Carbon levels can ONLY be increased by the addition of Organic Matter. The amount of organic carbon in soil is a balance between the build-up which comes from inputs of dead plant and animal material and the constant losses where the carbon is decomposed and the constituents separate to mineral nutrients and gases, or are washed or leached away. This theory limits the amount of carbon a soil can sequester to a theoretical ceiling of biomass introduced into the soil.

This theory overlooks critical aspects of microbiology of soils.



Increased Organic Matter does nurture micro-organisms which manufacture soil carbon. But there are at least two other ways to

[49] Dr Jeff Baldock, presentation to Carbon Farming Conference, Orange, November 2009

increase carbon in soils:
1. Microbial Community Optimisation; and
2. Phototrophism (or in-soil photosynthesis).

Microbial Community Optimisation: Microbial communities are at their most effective when they are balanced. When one or several links in the chain are missing, the processes of decomposition and photosynthesis can never be fully effective. Just as a football team with several positions unmanned cannot hope to score. Inoculating soil with the missing members of the community is like putting players into empty positions. The effectiveness of the team is increased by an order of magnitude.

Photosynthetic Microbes: There is a class of microbial life called 'autotrophic' or 'phototrophic' that do not rely on Organic Matter for their sustenance. They use solar energy to grow via the process of photosynthesis. Cyanobacteria and Algae are examples. These add Carbon independently of other processes.

Autotrophic bacteria obtain their energy from sunlight (by photosynthesis) or the oxidation of ammonium, sulfur, and iron. They get their carbon from carbon dioxide.

- phototrophic cyanobacteria
- green sulfur-bacteria
- some purple bacteria
- many chemolithotrophic species, such as nitrifying or sulfur-oxidising bacteria.[50] Many species of algae live in soils and photosynthesise their carbon as plants do.

Appendix 4: The Anti-Science of Soil Carbon

The following is a prime example of three characteristics of the Anti-Science of Soil Carbon: 1. Complexity as a reason why soil C should not be traded, rather than as a problem seeking a solution; 2. Scientists commenting on areas beyond their expertise without declaring their limitations, and 3. hysteria.

"While there is doubtless substantial technical potential to increase C-storage in grazed Australian ecosystems above- and below-ground, an adequate information base for accurately quantifying that expected potential for any specific changed management regime does not exist. It is not yet clear that reduced animal production is always necessarily a concomitant to achieving increased soil C stocks, although that seems logical for most situations. This poor state of the information-base will be inhibitory to the uptake of any market-based C-trading or GHG-trading system for grazing land based approaches.

[50] Hellingwerf K, Crielaard W, Hoff W, Matthijs H, Mur L, van Rotterdam B (1994)."Photobiology of bacteria". Antonie Van Leeuwenhoek 65 (4): 33147. doi:10.1007/BF00872217. PMID 7832590.

There are numerous complicating factors that will need to be addressed and dealt with explicitly in any market-based GHG trading scheme that involves C-sequestration into grazed ecosystems. These include, linked emission and/or uptake of methane and nitrous oxide associated with management changes for achieving changed C-sequestration, the impact on C-stocks of wildfire frequency and intensity, compensatory non-domesticated animal grazing, and large scale movement of high-C surface topsoil by flood and wind, difficulties of defining baseline C-stocks and baseline GHG fluxes from each patch of land under consideration especially when the requisite baseline is in the past, long time-frames (several decades) required and high expense for measuring change in C-stocks in each patch of land under a scheme, the high actual input-value or opportunity-value of the mineral elements associated with increased organic C stocks, the special status of any lands that have already been defined as "Kyoto Lands" by coming under Kyoto Protocol arrangements, and the interaction of C-sequestration with other environmental externalities that are coming under different management policy arrangements such as interactions with hydrological and biodiversity policies.

"The existence of the above and other real-life complexities will render market-based C-trading schemes involving pastures, exposed to the risks of complicated, ill-conceived, ill-understood, poorly regulated financial instruments and arrangements that are replete with opportunity for fraudulent scams and inappropriate diversion of community wealth to the personal fortunes of scheme managers and traders, while not delivering the scheme objectives, reminiscent of those involved in the Global Financial Crisis of 2007-2009. Thus considerable attention to transparency of the scheme details, the demonstration of actual C-sequestration in each scheme by direct measurement of changing C-stocks and fluxes from measured baselines, and independent regulation of the arrangements by well-informed regulatory agencies, would be needed to deliver the objective of actually slowing the rate of global climate change and sustaining community support for such a venture."[51]

Appendix 5: Collaborative Science in Agriculture

Scientists are left to their own devices to interpret land management for agriculture. Their knowledge of emerging management practices appears to lag industry development. This leads them to construct methodologies that potentially do not reflect practical reality. This in turn could compromise the validity and value of the research.

Where the outcome of this research underpins public policy that will affect the financial well-being of an entire industry, it becomes a critical issue.

The Carbon Coalition recommends

[51] Roger M. Gifford, CSIRO Plant Industry, "Carbon sequestration in Australian Grasslands: Policy and Technical Issues", Proceedings of FAO workshop on The role of grassland carbon sequestration in the mitigation of climate change Rome, 15-17 April 2009

that a collaborative approach to science in Agriculture be pursued.

The professional farmer or grazier can assist the scientist to identify the landscape issues that should inform the construction of the study and help the team avoid pitfalls that are not obvious to the non-farmer. The farmer in turn will learn more about scientific method to improve their performance as "Agricultural Experimentalists".

Appendix 6: Paradigms are Political

Extracts from 'The Structure of Scientific Revolutions'. By Thomas Kuhn, Scientist and philosopher

The function of a paradigm

"A paradigm is a universally recognised achievement that for a time provides model problems and solutions to a community of practitioners."

"A paradigm is what the members of a scientific community share, and, conversely, a scientific community consists of men and women who share a paradigm,"

"A scientific community consists of the practitioners of a scientific speciality. To an extent unparalleled in most other fields, they have undergone similar educations and professional initiations; in the process they have absorbed the same technical literature and drawn many of the same lessons from it... The members of a scientific community see themselves and are seen by others as the men and women uniquely responsible for the pursuit of a set of shared goals, including the training of their successors. Within such groups communication is relatively full and professional judgements relatively unanimous."

"The study of paradigms... is what mainly prepares the student for membership in the particular scientific community with which he will later practice. Because he there joins men and women who learned the bases of their field from the same concrete models, his subsequent practice will seldom evoke overt disagreement over fundamentals. Men and women whose research is based on shared paradigms are committed to the same rules and standards for scientific practice. That commitment and the apparent consensus it produces are the prerequisites for normal science, ie. for the genesis and continuation of a particular research tradition."

Seeing the same thing differently

'No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the box are <u>often not seen at all</u>.'

"Paradigm changes do cause scientists to see the world of their research engagement differently."

'a switch in visual gestalt'

"Practicing in two different worlds, the two groups of scientists see different things when they look from the same point in the same direction… That is why a law that cannot be demonstrated to one group of scientists may occasionally seem intuitively obvious to another."

"Equally, it is why, before they can hope to communicate fully, one group

or the other must experience the conversion that we have been calling a paradigm shift."

Hearing the same thing differently

"The proponents of competing paradigms are always at least slightly across purposes. Neither side will grant all the non-empirical assumptions that the other needs in order to make its case…. They are bound to talk through each other. Though each may hope to convert the other to his way of seeing his science abd its problems, neither may hope to prove his case."

'"… the proponents of competing paradigms must fail to make complete contact with each other's viewpoints."

"Scientists debating the choice between successive theories… the vocabularies with which they discuss such situations consist predominately of the same terms… they must be attaching some of those terms to nature differently and their communication is inevitably only partial."

Defining science differently

'"… the proponents of competing paradigms will often disagree about the list of problems that any candidate for paradigm must resolve. Their standards or their definitions of science are not the same."

An argument between reasonable men and women

"If a paradigm is ever to triumph it must gain some first supporters, those who will develop it to the point where hardheaded arguments can be produced and multiplied… Becauscientists are reasonable people, one or another argument will ultimately persuade many of them. But there is no single argument can or should persuade them all. Rather than a single group conversion, what occurs is an increasing shift in the distribution of professional allegiances."

"At the start a new candidate for paradigm may have few supporters, and on occasions the supporters' motives may be suspect."

"If the paradigm is one destined to win its fight, the number and strength of the persuasive arguments in its favour will increase…. Gradually the number of experiments, instruments, articles, and books based on the paradigm will multiply…"

"Nature itself must first undermine professional security by making prior achievements seem problematic… Even when that has occurred and a new candidate for paradigm has been evoked, scientists will be reluctant to embrace it unless convinced that two all-important conditions are being met. First, the new candidate must seem to resolve some outstanding and generally recognised problem that can be met in no other way. Second, the new paradigm must promise to preserve a large part of the concrete problem-solving ability that has accrued to science through its predecessors."

Appendix 7: Presenting Data - Imposing A Pattern In Defence Of The Dominant Paradigm

The charts shown here were sent to the Coalition by a supporter who wishes to remain anonymous. The charts are to be found in the Australian Greenhouse Office's Technical Report 43, The Impact of Tillage On Changes In Soil Carbon Density with Special Emphasis on Australian Conditions. The comments are those of the source.

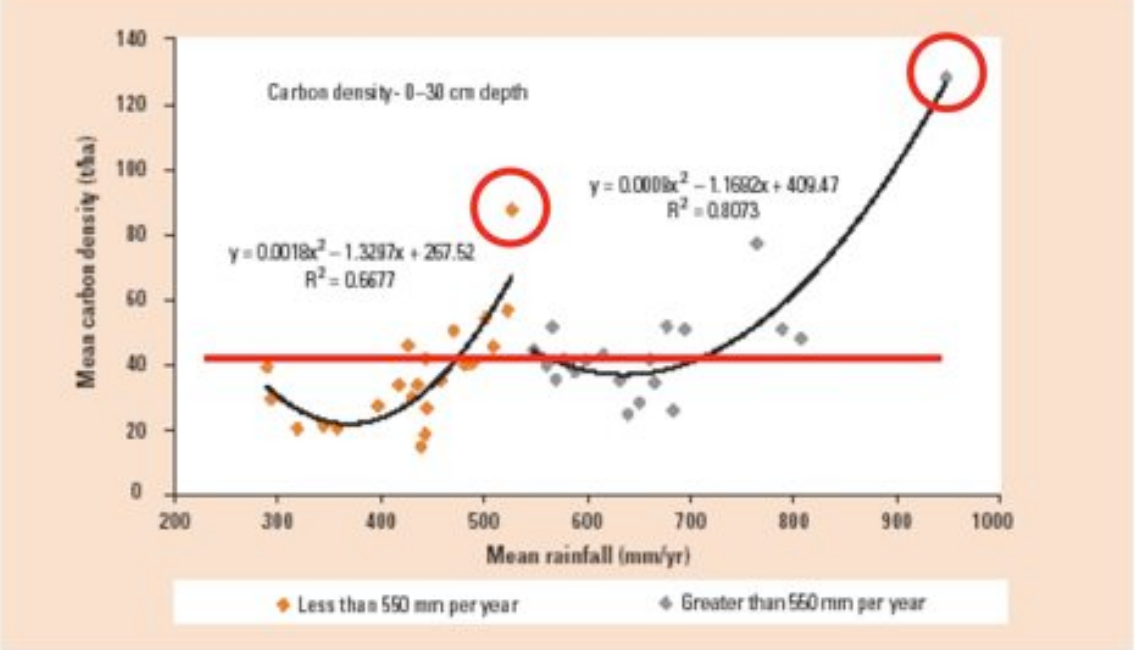


Figure 19b. Relationship between rainfall and soil carbon (less than 550 mm and greater than 550 mm rainfall).

Comment: The arbitary division of the data on the X Axis into two sub-axes creates the opportunity for the use of two out-of-sequence data points to create the impression that there is a relationship between rainfall and soil carbon when the raw distribution indicates no meaningful pattern.

Contrary to the curves imposed on the data, no link between carbon sequestration and either temperature or rainfall can be made by these studies. But the motivation to impose a known order on random data is not to be questioned. They are simply seeing what their worldview allows them to see. " Scientist and philosopher Thomas Kuhn in his book 'The Structure of Scientific Revolutions' says that the shared Values and norms of the scientific community form a barrier to out-of-paradigm phenomena and concepts. The shared values and norms of the scientific community form a barrier to out-of-paradigm phenomena and concepts. Kuhn says normal science aims to 'force nature into the preformed and relatively inflexible box that the paradigm supplies. No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the box are <u>often not seen at all</u>.'

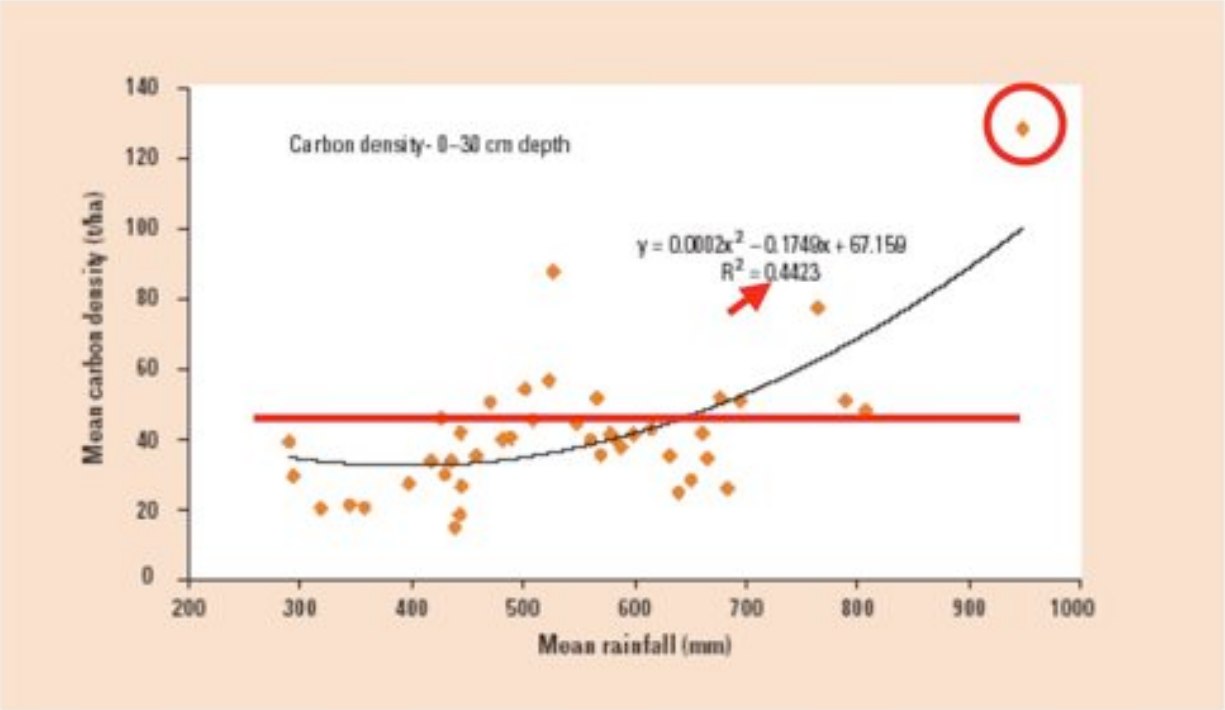


Figure 19a. Relationship between rainfall (up to 1000 mm/year) and soil carbon densities (t/ha).

Comment: The "R Factor" is so low as to render the reliability of the relationship between the two variables rainfall and soil carbon irrelevant.

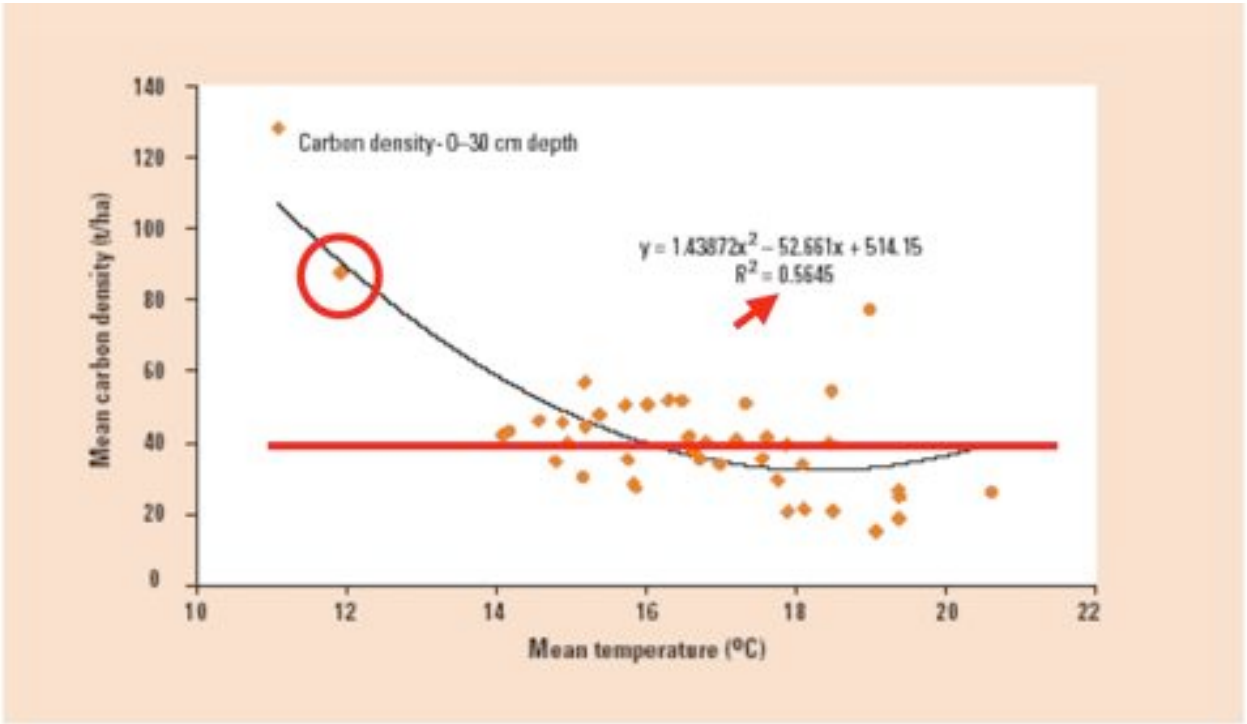


Figure 20. Relationship between mean daily temperature and soil carbon densities (t/ha).

Comment: Link between temperature and soil carbon uses sleight of hand to suggest it will be harder to sequester as temperatures rise. No professional statistician would allow one sample to skew the entire set. The "shotgun distribution" without it indicates no relationship between temperature and soil carbon readings.

We're all in this together

If the energy and resources deployed by scientists and others in promoting the barriers to soil carbon trading had been invested in finding solutions to these barriers, the world's farmers would be extracting vast quantities of Greenhouse Gases today and our world would be safer for everyone.

We can't defeat Climate Change while we are fighting each other. For better or worse, we're all in this together.

Carbon Coalition

The Carbon Coalition was established in 2006 to pursue the following Mission: "To see soil carbon traded and growers paid fairly for what they grow." It is an advocacy group. Members are farmers, scientists, agronomists, and city dwellers. The Coalition organised the first 5 "soil science summits' to bring scientists and farmers together to promote exchange and collaboration. These gatherings are now called Carbon Farming Conference & Expo. The Coalition prosecuted the case for soil carbon offsets, traded the first offsets on the unregulated market in 2007. It's commercial arm - a not-for-profit called Carbon Farmers of Australia – publishes the Carbon Farming Handbook and delivers workshops on soil carbon and trading, called Practical Carbon Farming.

Coalition Convenors Michael & Louisa Kiely are woolgrowers in Wellington District of Central West NSW.

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When there is a hole
in the bottom of the boat
and the water is rushing in,
we don't need a paper on the
physics of water entering a boat
through a hole in the bottom.
We need to plug the hole.

NOTE: This paper was peer-reviewed by a panel of Carbon farming practitioners and senior scientists and adjusted as a result.