SOIL CARBON SEQUESTRATION – AN OPPORTUNITY IGNORED

Submission written by Rod Rush on behalf of the Carbon Coalition Against Global Warming.

Historical Soil Carbon Loss

After the world's oceans soil is the largest global storehouse of carbon. In Australia soil carbon levels have run down dramatically since white settlement. Other parts of the world have seen similar declines. For example, the NSW Central West Catchment Management Authority estimates that soil organic matter levels in that catchment have fallen from 4.5% to an average of 2%. If the soils have a bulk density of, say, 1.2 gms/cm^3, this equates to release into the atmosphere of around 191 tonnes of CO_2 per hectare since white settlement.

Current framing practices have caused these losses. What are those practices? They include any practice that reduces soil biological activity, root growth and root depth and any practice that increases and sustains the breakdown on soil organic matter. These practices include excessive cultivation of soil (increases oxidation of organic matter), overuse of chemicals toxic to soil biology, long fallow of cropping paddocks, destruction of deep rooted perennial grasses, compaction of soil from farming systems, continuous set stocking of livestock leading to shallow rooted plants and bare ground.

Can Soil Carbon Levels be Increased?

The answer is yes if you ask the right people. So why hasn't the message got through to policy makers?

The short answer is because the scientists have been looking in the wrong places. Much of Australia (and the World) is farmed and grazed according to the industrial agricultural model where there is over use of cultivation, excessive use of pesticides, and set stocking of livestock. And these are the farms that scientists look at to determine what has been happening to farm soil carbon levels.

At the wind-up sessions of the Australian Greenhouse Office (AGO) in the middle of 2006 the CSIRO Land & Water project leader on soil carbon stated that it just was not possible to sequester carbon in soils at the rate necessary for it to be of advantage as a part solution to the problems of global warming. However, when the practices of "regenerative" agriculture were explained to him, and later to his successor, they expressed surprise and interest in conducting research into the contention that soil carbon levels can be raised, and raised quickly. There is currently no funding available for this project and to succeed in raising the required funds, years of prejudice have to be overcome.

Recently, the convenor of the Carbon Coalition travelled to the United States and over a three week period interviewed some leading soil experts on the ability of soils to sequester carbon and the means to measure and monitor movements in soil carbon over time. Some of their comments follow.

"Carbon sequestration in soil and vegetation is a bridge to the future. It buys us time while alternatives to fossil fuel take effect."

> Dr Rattan Lal, Director, Carbon Management and Sequestration Center
> Ohio State University, Columbus, Ohio
> Professor of Soil Science, College of Food, Agricultural, and Environmental Sciences, School of Natural Resources, Ohio State University
> Liebig Applied Soil Science Award, World Congress of Soil Science 2006

"Unlike many other technologies to offset fossil fuel emissions, land management for soil carbon sequestration can be implemented immediately, provided there are incentives to do so. An immediate offset of CO_2 emissions provides a significant delay in the rise of atmospheric of CO_2 concentration. By the time that land management carbon sequestration

begins to saturate the soil's capacity to store additional carbon, other methods of reducing emissions or sequestering carbon may be available or already in use."

> Professor Bruce McCarl, Agricultural Economist and Economist, Climate Change, Texas A&M University
> Member of the Intergovernmental Panel on Climate Change

"Terrestrial C sequestration could have an immediate application in climate change mitigation due to its availability, relatively low cost, and associated environmental benefits."

> R.W. Izaurrable and C.W.Rice, "Methods and Tools for Designing a Pilot Soil Carbon Sequestration Project", in Carbon Sequestration in Soils of Latin America, Lal et al. eds, 2006

Flux and soil variability are thrown in our faces whenever we ask for trading units of soil carbon. But one important US scientist has broken ranks with his colleagues to argue for sanity to prevail: "It is often pointed out that soils have a large amount of variability, but with knowledge of soil sciences and landscapes, variability can be described and sampling protocols can be developed to deal with this," writes Dr John Kimble in a paper published this year*. "One reason I feel people say that soils vary and SOC cannot be measured is that we soil scientists focus on showing variability, not on showing what we know about the variability. In soils we can go to a 100m2 field and sample every square meter and look at the differences we find. But if you sample every tree in a large area you would see a similar variability." Dr Kimble works for the US Department of Agriculture, National Resources Conservation Service, National Soil Survey Centre, Lincoln, Nebraska. "We too often focus on this [variability], worry about laboratory precision and field variation and do not look at the real world where most things are based on averages and estimated data. We tend to focus on finding variation and not on using our knowledge of soil science to describe what we know. All systems vary, but in soils we focus on a level of precision and accuracy that may not have any relevance to the real world because we can take so many samples and look at the variation."

> *Kimble, J., "Advances In Models To Measure Soil Carbon: Can Soil Carbon Really Be Measured?", in Lal, R., Cerri, C., Bernoux, M., Etchevers, J., and Cerri, E., eds., Carbon Sequestration in Soils in Latin America, Food Products Press, Birmingham, NY, 2006

Regenerative Agricultural Practices

The two best known examples are conservation and no till farming and planned or cell grazing. All of these practices build soil carbon under best practice management.

Sustainable is the wrong adjective. Very few people want to sustain their present land management practices. They want to regenerate their landscapes.

Soil carbon levels are built most rapidly in moist and cool environments where there is considerable organic matter input. A return to the 4.5% soil organic matter level in the NSW Central West CMA from 2.0% would increase the water holding capacity level of one square meter of soil by approximately 20 litres! A 1% increase would result in an additional 8 litres per square meter. There are reasons why some farms continue to have a green 'pick' and have harvested a crop, despite the current devastating drought.

Increases are possible in even the very hot areas of Australia. A key requirement is adequate ground cover (includes litter) to cool the critical top 15 cms or so where root growth and biological activity is the greatest. 100% ground cover is being achieved on top farms despite the drought. Compare this to what we all see as we drive around the countryside.

Conservation farming practices maximize ground cover through stubble retention, maintain a green crop on the land for most of the year (necessary to retain soil biology especially mycorrhizal fungi), practice minimum soil disturbance and feed their soil biology.

Approximately 50% of the carbohydrates produced in the leaves of plants are shed through their roots to feed beneficial microbial associations, hence the practice of maintaining green crops on the land. Other farmers actively feed their soil biology carbohydrates and protein in the form of such additions as composts, compost teas, kelp, seaweed and manures. This why such practices build soil carbon levels and why practicing farmers produce crops even in droughts.

There is frenzy of interest world wide in the apparent contradiction of the Amazonian Terra Preta soils. That is, pockets of apparently man made highly fertile soils in a very infertile leached landscape. It seems the ancients incorporated charcoal into these soils and this accounts for the differences. In some cases these soils are being mined for home garden supply but then regenerate to the same level after about 20 years! There is a highly acclaimed BBC documentary video on this subject entitled “Secrets of El Dorado” (available from BBC Sydney office) and a wealth of information in scientific publications and on the internet. There is potential to turn much of our urban and industrial wastes into relatively stable charcoal for use as a soil additive provided a cost effective means of carbonisation can be found. There is at least one Australian group, BEST based at Gosford, NSW, and several offshore (e.g. Eprida) working to develop such technology.

Planned grazing relies primarily on allowing grasses sufficient time to recover their root mass and energy reserves before the next grazing. Plants managed in this way have deeper and more vigorous root systems and produce much more available feed than most set stocked systems. It has been shown by New England researchers, Dr Earl and Dr Khan, that increases from 6 DSE’s/ha to 15 DSE’s/ha are possible in the New England under properly managed planned grazing regimes. These practices build soil carbon and provide feed reserves in droughts. Under the worst of the climate change scenarios unless graziers are using such practices much of the rangelands of Australia will change to semi-deserts due to current set stocking practices. Set stocking produces compacted soils with low water infiltration and plants with very short roots and low energy reserves and these plants are usually the ones that the animals have allowed to remain. The most favoured are continually re-eaten and hence die out.

As soil carbon levels increase so does the capacity of the soil to hold applied nutrients since organic carbon is a very effective colloid. For example, a light granite soil with little organic matter might have a soil cation exchange capacity (CEC) of 3 while one with good organic carbon levels might have a CEC of 10 (humus itself has a CEC of 240). Therefore, as organic carbon levels rise the soil will hold more of the minerals released by chemical and biological processes, and of fertilizers that are applied. In addition the soil will be better buffered to withstand salt fertilizers and natural soil salinity.

What Increases are Possible?

There is very little data available. Data collected in the New England under farm conditions suggests that in cold wet climates increases around 3.5% are possible within 5 years! Similar dramatic increases have been seen at Mt Barker in W.A. Increases of around 2% over several years are fairly widely claimed over much of the wheat sheep belt of N.S.W.

The reason the data is not available is that there has been no incentive for the farmers concerned to collect it. They know what is happening so they say they don’t need to support soil laboratories to tell them what they already know. Further, there has been scientific prejudice against many of the practices mentioned and for this reason the farmers concerned do not seek out such scientists or institutions. But hasn’t this always been the case i.e. the best farmers are often years ahead of the academics. Basically, however, what most of them are doing is looking at what nature does when left alone (e.g. bison moving across the American prairies “simulating” planned grazing) and what farmers did pre industrial agriculture (e.g. add organic matter to the soil).

Efforts by the long time campaigner for recognition of soil as a carbon store, Dr Christine Jones, to secure funding to investigate farm carbon sequestration on regenerative farms has been met by prejudice and a firm “no interest”. In addition, the prejudice is evident at a local

CMA level. Officers charged with the responsibility of monitoring landscapes leave seminars before sessions on regenerative practices are presented or discussed. For example, pasture cropping has been enthusiastically adopted by approximately 1,500 farmers across Australia since it dramatically lowers costs, produces similar yields to conventional high input systems, and dramatically increases perennial grass production and species diversity (no know can adequately explain why) yet local CMA officers leave before it is discussed proclaiming that it is against the Native Vegetation Act! It is no wonder regenerative farmers have such a poor opinion of the traditional science.

So Why Aren't More Farmers Adopting These Practices?

The reasons are many. For example, as just discussed, many in the scientific community are sceptical of the claims made and prejudiced. In addition, there are professional egos to contend with not to mention disaffecting current funding benefactors.

There is a huge investment in industrial agriculture and hence it continues to promote that model and denigrate the regenerative model. If everyone adopted no till practices for example, chemical and salt fertilizer sales would drop dramatically with flow on effects to those researching such methods (usually a very fertile field for them since it works against nature and not with it e.g. a chemical input usually creates another problem that has to be addressed).

Farmers are generally not well educated and the average age is somewhere in the 50's. They now rely heavily on merchandise agronomists tied to selling products since the various State governments reduced the number of independent agronomists. In addition they are generally very conservative as a group. There is also peer pressure to contend with.

Adoption of new technology can require a significant capital cost and many farmers do not have the skills to assess the cash flow effects of the expenditure.

And, if it needs to be said, because they are not being told about the benefits of regenerative agriculture it has not been properly investigated and the results disseminated etc.

Meanwhile, the best operators can see opportunity in the misfortune that is befalling their neighbours.

How Do We Get Farmers To Adopt These Regenerative Practices ?

The present rate of adoption is too slow to save the landscape.

The absolute driver of regeneration is soil carbon. Unless a farmer is building soil carbon levels he will not be regenerating his landscape. It needs to be said that there are some so called regenerative farmers who are currently not building soil carbon levels.

Therefore, there needs to be an incentive for farmers to change if they cannot see the benefits over their neighbour's fence (e.g. he has a crop when I don't; he is not feeding his sheep but I am?).

A price needs to be placed on soil carbon. This fits neatly with the climate change agenda.

Research Projects

There are a number of research projects that could be undertaken for relatively little cost. The Government must have experienced practitioners and scientists on its advisory panels otherwise the aims will be thwarted. A suggested list is provided below.

1. Research the soil carbon levels of the best regenerative farmers in Australia to establish both the amount being sequestered and the rate of sequestration. At the same time measure levels in non-regenerative farms to establish a base line.

2. Develop methodologies for base lining and on going monitoring of soil carbon levels in all landscapes. It may be that the methodology is as a simple as measuring water holding capacity which varies with soil organic carbon.

3. Review the current landscapes and productivity of regenerative and non-regenerative farms across Australia region by region during the current drought.

Political Opportunity

Allan Yeomans, in his 2005 book "Priority One", estimates that a 1.6% increase in soil organic matter levels in the 0.75 ha footprint each human has on the planet (or in the 8.5% of the planet that we actively control park land, rangelands, farm lands etc) is all that is required to bring atmospheric CO_2 levels down to those of the early 20th century. This would give the world the breathing space to develop the renewable energy technologies it needs. But we will only get one go at using the soil. While regenerative agriculture is also a greenhouse gas emitter these emissions are less than those of the industrial model. For example, cattle on native pastures emit much less methane than cattle on high grain diets. Grain prices under climate change are likely to rise since some grain growing areas are forecast to become too dry for their production. Therefore, as numbers in feedlots decline due to the price of grain numbers in rangeland areas can rise to take their place.

A 1% increase in soil organic carbon at the current NSW abatement scheme price of $14 per tonne of CO_2 equates to an approximate return to a farmer before monitoring costs of around $1,000 per hectare. Monitoring costs could be of the order of $25 per hectare (baseline measurement plus one further measurement). A minimum 1% increase should be possible across most of arable Australia.

This should be more than enough to get a lot of farmers interested. It would also attract the attention of investors and their targets would inevitably be the "worst managed farm in the best area". It would cause a dramatic change in the structure of Australian agriculture. Inefficient and ineffective farmers would be able to leave the industry with a reasonable retirement packages and be replaced with a younger and more receptive generation.

Such a change would revitalise (regenerate!) country towns. Degeneration of the landscape is the primary cause behind the deterioration of country towns and communities.

City folk could also be brought into the movement. Home gardens, city parks and gardens and nature reserves could all be included. Many of these might achieve higher increases. Residents and councils could all claim carbon credits. It would unify town and country in a common cause.

The "Green Agenda" would become mainstream, with the movement being taken over by the National and Liberal Government. The city based electorate would finally believe that their country cousins are the most ardent conservationist in the country.

Such a programme would deliver the moral high ground to Australia and world leadership on the climate change issue and model for other countries to follow. Further, it is a programme that Australia can adopt without waiting for countries such as India, China and The United States to join in due to the non-climate change benefits for our landscape.

There is only one downside that we can think of. Because water infiltration and water holding capacity would dramatically increase, many farm dams would no longer fill quickly after a thunderstorm. However, in the medium term groundwater reserves would refill and springs and streams would once again flow. We think society can live with those changes.

Recommended Contacts

The contacts/reference points listed below are by no means an exhaustive list. These people can refer interest to others. We are, for example, aware of supporters in organisations such

as the now defunct Australian Greenhouse Office and government departments who currently do not see it as a prudent career move to be at odds with the official line.

Soil Carbon Measurement & Monitoring
Dr Jeff Baldock, CSIRO Land & Water, Adelaide: Jeff.Baldock@csiro.au . Dr Baldock is not necessarily a supporter of all that is written in this paper.
Professor Rattan Lal, School of Natural Resources, Ohio State University, USA

Soil and Landscape Ecology and Carbon Sequestration
Dr Christine Jones, Armidale. NSW: Christinejones22@aol.com

Regenerative Farming Practices
Dr Christine Jones, Armidale. NSW: Christinejones22@aol.com
Dr Judi Earl, Guyra. NSW: judiearl@auzzie.net
Rod Rush, Armidale. NSW: rodrush@bigpond.net.au

Planned or Cell Grazing
Terry McCosker, Resource Consulting Services, Yeppoon. Qld: tmccosker@rcs.au.com
Dr Judi Earl, Guyra. NSW: judiearl@auzzie.net

Pasture Cropping
Colin Seis, Gulgong. NSW: colin@winona.net.au

The Carbon Coalition
Michael Kiely, Gulgong, NSW: Michael@newhorizon.au.com

For more general information or comments on the content of this document please contact, Rod Rush, on ph 02-67723125 or email rodrush@bigpond.net.au; or Michael Kiely on ph 02-63740329 or email Michael@newhorizon.au.com