E – BRIEF

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Agriculture, Landscapes and Carbon

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1 Introduction

This E-Brief reviews the contribution of the agriculture sector to Australia's greenhouse gas emissions. The potential of agriculture and landscape management to sequest / mitigate[1] greenhouse gases is then analysed.

1.1 Australia's greenhouse gas emissions

In 2007, Australia's national inventory of greenhouse gas emissions was 541 Mt CO_2-e (millions of tonnes of carbon dioxide equivalent). The Energy sector was the largest source of emissions, comprising 75.4% of the national inventory total. The second largest source was the Agriculture sector (16.3%).[2]

1.2 Agriculture sector emissions

The sources [and amounts in 2007] of Agricultural emissions are:

- Enteric fermentation in livestock – emissions associated with microbial fermentation during digestion of feed, mostly by cattle and sheep [58 Mt];
- Manure management – emissions associated with the decomposition of animal wastes while held in manure management systems [3.5 Mt];
- Rice cultivation – methane emissions from anaerobic decay of plant and other organic material when rice fields are flooded [0.2 Mt];
- Agricultural soils – emissions associated with the application of fertilizers, crop residues and animal wastes to agricultural lands [15 Mt];
- Prescribed burning of savannas – emissions associated with the burning of tropical savanna and temperate grasslands for pasture management, fuel reduction and prevention of wildfires [12 Mt];
- Field burning of agricultural residues – from burning cereal and other crop stubble, and burning of sugar cane prior to harvest [0.3 Mt].

In 2007 livestock emissions were responsible for 69% of the Agriculture sector's emissions. Greenhouse gas emissions from Agriculture increased by 1.5% between 1990 and 2007.[3]

2 Terrestrial Carbon in Australia

It has been estimated that the total stock of carbon in the world's vegetation and soils is approximately 2,300 billion tonnes, about three times more than in the atmosphere. A 15% increase in the world's terrestrial carbon stock would remove the equivalent of all the carbon pollution emitted from fossil fuels since the beginning of the industrial revolution. The total stock of carbon in the Australian landscape is about 28 billion tonnes, half of which is found in native

forests and woodlands, and half in grasslands and crop land.[4]

More recently, an area of the climate change debate has re-focused from the contribution of agriculture to greenhouse gas emissions to how much agriculture and the Australian landscape can contribute to national greenhouse gas sequestration / mitigation targets.

For instance, the Wentworth Group of Concerned Scientists states that, fundamental to any solution to climate change is reducing emissions from energy generation, manufacturing and transport. However, it continues that it will be next to impossible for nations to achieve the scale of greenhouse gas reductions required in sufficient time to avoid dangerous climate change, unless carbon is removed from the atmosphere and stored in vegetation and soils.[5]

3 Sequestration and Mitigation of Greenhouse Gases

The Garnaut Climate Change Review wrote extensively on transforming rural land use, and the considerable potential for biosequestration of greenhouse gases in rural Australia. The realisation of this potential would greatly reduce the costs of mitigation in Australia. It would also favourably transform the economic prospects of large parts of remote rural Australia. Full utilisation of biosequestration could play a significant role in the global mitigation effort. Garnaut concluded that this is an area where Australia has much to contribute to the international system.[6]

An August 2009 CSIRO report supported the broad thrust of the land use biosequestration arguments in the Garnaut Review. CSIRO found that nationally, there is a potential 1000 Mt CO_2-e per year (for the next 40 to 50 years) of greenhouse gas sequestration / mitigation in the Australian landscape.

The Wentworth Group note that if just 15% of this biophysical capacity to sequester carbon was used, it would offset the equivalent of 25% of Australia's current annual greenhouse emissions for the next 40 years.[7]

There are three main ways that carbon sequestration can occur in the landscape:

- Agriculture;
- Forestry;
- Bioenergy.

The sequestration / mitigation potentials as estimated by the CSIRO are listed in the following tables.

Agriculture	**National potential (Mt CO2-e)**
Rehabilitate overgrazed rangelands, restoring soil and vegetation carbon balance	100
Mitigation of emissions from savanna burning	13
Build soil carbon storage and mitigate nitrogen oxide emissions for cropped land	25
Reduce livestock enteric emissions and structural change in industry	26
Total Agriculture	**164**

Forestry	**National potential (Mt CO2-e)**
Change land use to carbon forestry –primary goal is carbon sequestration	750
Increase carbon banks in pre-1990 eucalypt forests	47
Carbon positive management of regrowth vegetation and remnant forest (reduce land clearing)	56
Total Forestry	**853**

The national potential of bioenergy, the substitution of fossil fuels with biofuel, was not estimated by this CSIRO report. However, in Queensland the potential was estimated at 29 Mt CO_2-e per year.

Carbon forestry was defined as forestry which is not harvested and which would receive payments for carbon sequestration. Their location might be anywhere in the landscape – the primary driver being a carbon market.[8] Clearly, the potential for forestry in particular to become a major player in the carbon market is significant.

The CSIRO report noted that the main uncertainties to which the estimates are highly sensitive include:

- Predicted rates of carbon sequestration;
- Future carbon prices, and
- Land availability, including competition for other land uses and community attitudes.

Large-scale afforestation may provide significant biodiversity benefits. However, compared to grassland areas forests soak up water, and hence reduce the amount of runoff to rivers and streams. Large scale forestry projects may be subject to water licensing in catchments that are over-allocated or approaching full allocation.

CSIRO concluded that Australia has the opportunity to offset a significant proportion of our greenhouse gas emissions, by storing carbon in the landscape and changing the emissions profile from rural land use. However, it warned that an integrated approach to greenhouse gas emissions abatement across agriculture, energy and transport sectors is still important. This is because sequestration has large natural uncertainties compared to achieving similar abatement through a reduction in the burning of fossil fuels.[9]

3.1 Soil and carbon

Carbon exists in soil in two forms—organic and inorganic. The inorganic form is relatively stable and is not strongly influenced by land management. In contrast, the organic form, which comes from the decay of organic matter, is less stable and will vary depending on factors that influence this decay, such as climate, soil type and land management practices. [10]

The Wentworth Group of Concerned Scientists note that agricultural practices over the past century have mined Australian soils of their carbon stores. Nearly 40% of carbon stocks have been lost from Australia's cropping soils. As a consequence, many soils now have significant capacity to store additional carbon. With livestock grazing and cropping land occupying over 400 million hectares, nearly 60% of the Australian continent, even small increases in soil carbon can produce significant offsets in greenhouse gas emissions.[11]

Organic soil carbon can be divided into three 'pools' according to how fast it breaks down and is replaced. These pools are: fast (e.g. annual), slow (e.g. decadal) and passive (e.g. millennial). For carbon sequestration and carbon trading purposes, it is desirable to increase the total amount of carbon especially in the slow and passive pools (referred to as the 'stable' pools). The amount of organic soil carbon in the stable pools can be increased by adding plant material above and below the soil surface, and by altering the rates at which this material decomposes. This may be achieved through some land management

changes or through the application of external sources of carbon, such as biochar (see section 3.2) or manure, to the soil. The Bureau of Rural Sciences notes that life-cycle analyses are required to determine if there is a net gain in carbon sequestration with these proposed measures.[12]

Standard methods of measuring organic soil carbon and attributing organic soil carbon to the individual pools are generally slow and expensive. To quantify carbon in units suitable for carbon trading, combinations of methods would be required to determine the amount of carbon and how it changes spatially, vertically and under different management regimes.[13]

In Australia, several models are used to estimate changes in organic soil carbon with reasonable accuracy. The Bureau of Rural Sciences notes that these models will require more work before they can provide good spatial resolution and an acceptable estimate of uncertainty at the individual landholder level.

The Bureau concluded that whilst decisions on how to manage soil carbon are likely to continue to have some uncertainty, with more improvements in methods, soil carbon could become a viable component of carbon trading schemes.[14]

3.2 Biochar

Biochar is the carbon-rich product obtained when biomass, such as wood, manure or leaves, is heated at relatively low temperatures (<700°C) in a closed container with little or no oxygen. This process often mirrors the production of charcoal. However, it distinguishes itself from charcoal by the fact that biochar is produced with the intent to be applied to soil as a means of improving soil productivity, carbon storage, or filtration of percolating soil water.[15]

The central quality of biochar and char that makes it attractive as a soil amendment is its highly porous structure, potentially responsible for improved water retention and increased soil surface area. Addition of biochar to soil has also been associated with increased nutrient use efficiency, either through nutrients contained in biochar or through physico-chemical processes that allow better utilisation of soil-inherent or fertiliser-derived nutrients.

It is generally accepted that biochar is a highly stable form of carbon and as such has the potential to form an effective carbon sink, therefore sequestering atmospheric CO_2. The CSIRO notes that estimates on the mean turnover time of biochar in soil vary from hundreds to thousands to tens of thousands of years.[16]

The production of biochar constitutes both a tool for carbon sequestration and avoided emission. It is argued that sequestration of carbon in biochar allows for a much longer storage time compared with other terrestrial sequestration strategies, such as afforestation.[17]

4 National Policy Responses

The Rudd Government has confirmed its commitment to cut greenhouse gas emissions from a year 2000 base by an unconditional 5%, with up to 15% and 25% dependent on the extent of other countries targets and international agreements.[18]

The Australian Government has committed itself to a national carbon emissions trading scheme – known as the Carbon Pollution Reduction

Scheme (CPRS). Legislation for this has been twice rejected by the Australian Senate, and the Government re-introduced the legislation on 2nd February 2010.

The Government has determined that agriculture will not be included in the proposed CPRS. Instead, it advised that CPRS permits will be provided for abatement of agricultural emissions from such activities as livestock / manure management or fertiliser use. In addition, offset credits will be developed for use with agricultural soils, including biosequestration through soil carbon and biochar.[19]

4.1 The CPRS and reforestation

Under the proposed CPRS, permits will be issued for eligible reforestation projects. These permits can be sold in the voluntary market or to entities that have Scheme obligations. To be eligible for units, the forest must:

- be established by direct human induced methods on land that was clear of forest on 31 December 1989;
- be established in patches of 0.2 hectare or more;
- have a potential crown cover of at least 20 per cent; and
- have the potential to reach a height of at least 2 metres.

These are the criteria for forests recognised in Australia's Kyoto Protocol national account. Units will only be issued for net increases in greenhouse gas removals that occur after 1 July 2010, and only after the carbon stored in the forest is greater than it was in 2008. This 2008 'baseline' prevents forests being felled specifically to establish new forests to claim scheme units. Existing native forests, forest established on land forested on 31 December 1989 and other types of natural vegetation (e.g. grasslands and shrubs) will not be eligible for units under the Scheme.

4.2 The Federal Opposition's policy

Opposition Leader Hon Tony Abbott MHR has firmly rejected the concept of an emissions trading scheme, and on 2 February 2010 announced the new Coalition climate change policy. Part of the policy involved the agricultural sector. Mr Abbott stated:

> The single largest opportunity for CO2 emissions reduction in Australia is through bio-sequestration and the replenishment of soil carbon in particular. Significantly increasing soil carbon levels also boosts agricultural productivity and water efficiency.
>
> The Coalition will use the Emissions Reduction Fund to deliver about 85 million tonnes per annum of CO_2 abatement through soil carbons by 2020 with an initial purchase of 10 million tonnes of abatement through soil carbons by 2012-13.[20]

The differing approaches of the Federal Government and Opposition have sparked widespread debate on what is the best policy for farmers and the landscape. The National Farmers Federation stated that it was encouraged that the Coalition has committed to an incentive based scheme for farmers to drive abatement from their sector.[21] In contrast, Peter Cosier from the Wentworth Group noted that farmers are likely to get paid a higher price for the biosequestration of carbon under the Government's proposed CPRS. Cosier noted the Coalition policy focus on soil carbon, whilst the CPRS has a broader approach, including the

biosequestration of greenhouse gases on reforestation of degraded land.[22]

5 Conclusion

In 2007 Australia's greenhouse gas emissions was 541 Mt CO_2-e. The CSIRO has found that nationally, there is a potential for the Australian landscape to sequester or mitigate almost twice that amount per year for the next 40 to 50 years.

Much of this terrestrial sequestration potential involves spatially extensive activities, where small contributions by many individual landholders can, as a group, contribute significantly through application over large areas.

This means that their widespread adoption could see them transform rural landscapes with substantial benefits. However, the CSIRO also warns that, without a planned and systemic approach to their implementation, adverse outcomes for the environment, productive capacity, rural livelihoods and commodity supplies are possible.

The Wentworth Group agrees with this prognosis, and argues that whilst the use of terrestrial carbon is an essential ingredient to help meet emission reduction targets, it is the role of government to manage the risks. These included the loss of prime agricultural land to carbon forestry, impacting on food and fibre production, regional jobs and the security of fresh water resources.

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1 Sequestration is the removal of carbon from the atmosphere by, and storage in, terrestrial or marine reservoirs. Biosequestration is the removal from the atmosphere and storage of greenhouse gases through biological processes, such as growing trees. Mitigation is the reduction in the source of, or enhancement of the sinks for greenhouse gases.

2 Australian Government, H*National Greenhouse Gas Inventory accounting for the Kyoto target*H. May 2009.

3 Australian Government, H*National Greenhouse Gas Inventory accounting for the Kyoto target*H. May 2009.

4 Wentworth Group of Concerned Scientists, HOptimising Carbon in the Australian LandscapeH. October 2009.

5 Wentworth Group of Concerned Scientists, HOptimising Carbon in the Australian LandscapeH. October 2009.

6 Garnaut,R. H*The Garnaut Climate Change Review*.*H* 2008

7 Wentworth Group of Concerned Scientists, HOptimising Carbon in the Australian LandscapeH. October 2009.

8 Two types of carbon forestry, hardwood plantings and environmental 'woodland' plantings were assessed. In regions with greater than 600 mm annual rainfall an average-weighted, annual rate of carbon sequestration for the two systems over 40 years (2010 to 2050) was estimated to be 12.7 t CO2 ha-1 yr-1. This was further discounted by an arbitrary 'risk buffer' of 30% to give an annual rate of 9 t CO2 ha-1 yr1. This value of 9 t CO2 ha-1 yr-1number can be multiplied by any area deemed suitable, and the number of years of sequestration, to indicate ranges in total carbon sequestration and the potential for carbon forestry to off-set greenhouse gas emissions.

9 CSIRO, HAn Analysis of Greenhouse Gas Mitigation and Carbon Sequestration Opportunities from Rural Land UseH. August 2009.

10 Walcott,J, Bruce,S,Sims,J. H*Soil carbon for carbon sequestration and trading: a review of issues for agriculture and forestry*H. Bureau of Rural Sciences, March 2009.

11 Wentworth Group of Concerned Scientists, HOptimising Carbon in the Australian LandscapeH. October 2009.

12 Walcott,J, Bruce,S,Sims,J. H*Soil carbon for carbon sequestration and trading: a review of issues for agriculture and forestry*H. Bureau of Rural Sciences, March 2009.

13 Walcott,J, Bruce,S,Sims,J. H*Soil carbon for carbon sequestration and trading: a review of issues for agriculture and forestry*H. Bureau of Rural Sciences, March 2009.

14 Walcott,J, Bruce,S,Sims,J. H*Soil carbon for carbon sequestration and trading: a review of issues for agriculture and forestry*H. Bureau of Rural Sciences, March 2009.

15 Lehmann,J and Joseph,S., 'What is Biochar' in HBiochar for Environmental

Management, An IntroductionH. March 2009.

16 Sohi,S. *et al*, H*Biochar, Climate Change and soil: A Review to Guide Future ResearchH. CSIRO Land and Water Science Report 05/09, February 2009.*

17 Sohi,S. *et al*, H*Biochar, Climate Change and soil: A Review to Guide Future ResearchH. CSIRO Land and Water Science Report 05/09, February 2009.*

18 Sen Hon Penny Wong, Minister for Climate Change and Water, H*Media Release – Australia's Submission to the Copenhagen AccordH*. 27 January 2010.

19 Australian Government, HAgricultureH (and the CPRS)

20 Hon Tony Abbott, Press Release: HDirect Action on the Environment and Climate ChangeH. 2 February 2010.

21 National Farmers Federation, H*Media ReleaseH*: "Coalition climate policy principles for farmers encouraging". 2 February 2010.

22 Carbon and Environment Daily, H"Wentworth Group: Coalition plan 'duds' farmers."H 4 February 2010.