GREENPEACE
www.greenpeace.org.au

SUBMISSION

Submission to the Senate Standing Committees on Environment and Communications inquiry into Carbon Farming Initiative Bills.

8th April 2011

Greenpeace is pleased to make a submission to the Senate Committee Inquiry into the Carbon Farming Initiative. Greenpeace strongly supports action to abate greenhouse gas emissions in the agricultural and land sector and strongly supports measures to improve farming practices, ecological and biological diversity in agricultural areas and diversity of income opportunities for rural regional areas.

Unfortunately, the CFI Bill will not accomplish these outcomes. We urge the Committee to recognise the complexities and difficulties of this scheme and to assess thoroughly alternatives to the current proposal.

A fund for the purposes of securing abatement of emissions from land use sectors may be a simpler and, certainly in the short term, a preferable model for confronting the need to improve our land use practices.

This submission is comprised of our previous submission to the CFI discussion paper and the table below, which analyses the extent to which the current Bill addresses critical issues raised in our initial submission to the discussion paper.

As shown in the table below, the CFI Bill fails to meet many criteria needed to ensure it will lead to real reductions in greenhouse emissions, and real benefits for the environment.

Greenpeace recommends that the Bill be amended to ensure it meets the criteria laid out in the table below.

Table: Comparison ideal CFI legislation and the current CFI Bill

Criteria that must be met by the CFI legislation.	Does the CFI Bill meet these criteria?
The CFI legislation must prioritise avoiding and reducing emissions from agriculture and forestry.	The Bill fails in this key area. The bill prioritises the creation of a carbon credits "offset" market, rather than the reduction of emissions from agriculture and forestry. The market is opt-in (meaning that emitters in the land use sectors will not have to reduce their emissions), and there is no guarantee that carbon offset credits will amount to genuine emissions reductions, as discussed below.
Emissions abatement must be genuine. That is, must be measured, and verified.	It is possible that emissions abatements under the CFI Bill will be genuine, but it is far from guaranteed. Actual abatement will depend on the rigour of the offset standards to be developed. Provisions in the Bill could be strengthened. For instance, s 133(1) (b) – Offsets Integrity Standards – reads: "*the removal, reduction or emission, as the case may be, should be:* *(iv) measurable; and* *(v) capable of being verified.* The wording in this section needs to be made much stronger, to ensure that genuine abatement is mandatory. In fact, all of the provisions in section 133 are worded in 'should' terms, rather than 'must', which substantially weakens the integrity of the Bill.
Soil sequestration in agricultural soils must be excluded from the scheme, as emissions abatement from soil sequestration is uncertain and impermanent.	The Bill fails to meet this important criterion. Soil sequestration projects are permitted in s54.
Abatement must be guaranteed long term (permanent). Greenpeace resubmits that there should be a 50% discount on sequestration credits to account for their uncertain permanence.	The Bill relies on a very low 5% risk reversal buffer, which is not an accurate reflection of the reversal risks. The Bill does have provisions to force project proponents to relinquish credits in certain circumstances (Part 7), although these section is too weak.

	weak.
The Bill must ensure that all emissions abatements credits are "additional". That is, projects that would or could have happened anyway, regardless of the CFI legislation, must not be qualify for emissions abatement credits.	The Bill fails on this critical matter. The criteria for additionality in Section 41 are very weak. Determination is based primarily on a 'common practice' test rather than the more commonly used, and far more robust test of 'would the abatement have occurred in the absence of the CFI legislation'. The common practice test is not well defined. For example - is organic farming common practice? Is burning of cane stubble common practice?
The Bill must not jeopardise efforts to ensure that emissions from the heavily polluting energy sector peak and begin to decline by 2012.	The Bill actually seems designed to allow emissions in energy and other sectors to continue to rise, while being "offset" with credits generated under the CFI legislation. One way to help limit or resolve this key problem would be to place caps on the number of credit units available to other sectors.
The Bill must ensure that carbon emissions abated by a project are not simply relocated to another site. That is, the Bill must prevent "leakage" of carbon emissions. Greenpeace resubmits that CFI credits should be based on state/territory level mitigation commitments, not project-based, to help resolve this issue.	The CFI Bill is project-based, with little effort to prevent carbon leakage, or ensure project additionality. Leakage provisions in the exposure bill (s102), although quite weak, are now removed.
Emissions abatement units generated under the Bill must be Kyoto compliant, to ensure they are rigorous.	The Bill allows both Kyoto-compliant, and non-Kyoto compliant projects to be accredited.
The Bill should create a fund from forthcoming carbon price revenue to fund greenhouse gas mitigation in the agriculture, forestry and land use sectors. This would maximise biodiversity and farm productivity co-benefits and build climate resilience into the Australian landscape.	The Bill fails to do this, relying exclusively on a market system, which is unlikely to provide a range of needed co-benefits. Greenpeace recommends the Senate examines the extent to which even the best designed credit trading systems (for example the Kyoto Protocol's Clean Development Mechanism) have resulted in abatement and benefits to local communities. Greenpeace also recommends the Senate conduct an analysis of what kind of trading system will emerge from the CFI, who will control it, where the benefits will flow and whether the price and benefits reflect abatement values rather than exchange values.
The Bill should encourage secure and resilient farm productivity, food security, improved	The Bill generally fails in this area. The Bill does not include any measures to protect food production or

	input farming systems. Minimal steps are taken in the Bill to alter destructive farming practices and move towards more climate resilient models of farming. It is possible that some environmental outcomes will be seen with avoided emissions projects (s53) but this is not clear and it is not part of the objects of the Bill.
The Bill should secure environmental sustainability and biodiversity protection.	The Bill contains some small measures aimed at sustainability and biodiversity protection, but is generally very weak in this area. It does not allow offset projects that involve native forest clearing or materials from native forest clearing. The Bill allows the Minister to exclude certain projects that will have a significant impact on water availability (however, not water quality) and biodiversity conservation. Other exclusions may be specified in the regulations. However, significant potential impacts are not defined in the Bill, and no pro-active measures are required in order to determine whether significant impacts are likely, nor are applicants for projects required to examine the potential impacts of their projects on biodiversity or ecological sustainability. Under the Bill, projects must be consistent with relevant regional natural resource management plans, which may have some environmental benefits. These elements do not however recognise that the CFI should operate with ecosystem and land use improvements in a co-beneficial way. Good carbon farming initiatives should, by definition, also be good biodiversity, ecosystem and land use initiatives.
The Bill should restrict reafforestation and revegetation projects to ecological restoration, rather than allow industrial economic plantations that have zero or negative environmental benefits.	As discussed above, there is nothing in the current Bill that will ensure that approved projects are beneficial to the environment. It is likely that some projects will have negative impacts.
The Bill should avoid voluntary markets, which have been shown to be inadequate at achieving significant long term greenhouse pollution.	The Bills purpose is to establish a voluntary market of carbon credits. The agricultural and land-use sector would be under no obligation to reduce carbon emissions.

Appendix: Greenpeace's initial submission to the Design of the Carbon Farming Initiative Consultation Paper.

Recommendations

The Carbon Farming Initiative (CFI) should;

1. Not jeopardise efforts to ensure Energy emissions peak by 2012 and rapidly decline thereafter.
2. Secure farm productivity and food security and improve environmental sustainability and biodiversity protection.
3. Lead to real, measurable, additional, long-term and verifiable national emission reductions from Australia's Agriculture and Land Sector.
4. Restrict Reforestation and Revegetation projects to ecological restoration with mixed native vegetation and forest species that reflect regional and local ecological communities.
5. Encourage farm practices that are based on biological farming methods, reduce chemical inputs, fuel use, water consumption, enhance soil productivity and diverse cropping systems.
6. Reduce GHG from manure management through the development of regional biogas plants for beneficial use methane production.
7. Reduce emissions from agricultural soils, but should exclude crediting from CO2 sequestered by agricultural soils.
8. Improve transparency of deforestation emission data.
9. Exclude non-human induced reforestation.
10. Be financed by a percentage of revenue derived from the introduction of a price on Australia's GHG emissions in other sectors.
11. Be financed through a substantial increase in Australia's stated GHG reduction target for the 2013-2020 period.
12. Be based on State and Territory Agriculture and Land Sector GHG mitigation performance against a long-term historical base period.
13. Apply a 50% discount to any sequestration credits.

Introduction

Greenpeace is grateful to be given the opportunity to express its views on the DCCEE *Design of the Carbon Farming Initiative Consultation Paper*. These comments are provided with the intention of improving the CFI and represent neither endorsement of or opposition to the initiative.

Global agriculture contributes significantly to greenhouse gas emissions (GHG) and steps to reduce these are necessary and urgent. Agricultural soil, livestock and deforestation directly emit large amounts of potent greenhouse gases. Agriculture's indirect emissions include fossil fuel use in farm operations, the production of agrochemicals and the conversion of land to agriculture. The total global contribution of agriculture, considering all direct and indirect emissions, is between 8.5 – 16.5 billion tones (GT) expressed in carbon dioxide equivalent[1] CO_2-eq, which represents between 17 and 32% of all global human-induced GHG emissions, including land use changes.[2]

Greenpeace views the CFI as a tremendous opportunity to reduce Australia's contribution of these emissions as well as to improve Australia's unsustainable agricultural practices and begin to build climate resilience into our ecosystems and farm productivity.

The Australian Government should therefore focus its attention on reducing emissions from its Agriculture and Land Sector and safeguard its biodiversity and food security against climate impacts. Attempting to sequester carbon from the atmosphere through an offset mechanism is no alternative to reducing GHG emissions entering the atmosphere. While drawing down GHG from the atmosphere will be necessary, it is irresponsible to offset actual GHG emissions on uncertain and impermanent sequestration while GHG emissions from both fossil fuels and agricultural activities are so dangerously high.

It is important to note that agriculture, forestry and other land use have a direct impact on, and will feel some of the most profound and direct impacts of climate change over the next few decades.[3] These impacts will have catastrophic effects on global food production [4] and may further exacerbate climate dynamics should feedback thresholds be breached.

The latest Intergovernmental Panel on Climate Change (IPCC) report predicts the probability of more heat waves, heavy rainfall, droughts and other extreme weather throughout the 21st century.[5] Increasing temperatures, declining and more unpredictable rainfall, more frequent extreme weather and higher severity of pest and disease are among the more drastic changes that would impact food production.[6] The biggest problem for food security will be the predicted increase in extreme weather, which will damage crops at particular developmental stages and make the timing of farming more difficult, reducing incentives to cultivate.[7]

The Australian population is projected to grow from 20 million in 2003 to 26.4 million in 2051. Australia currently exports most of its agricultural productivity but whether it will be in a position to feed its

---

[1] Emissions of greenhouse gases nitrous oxide (N_2O) and methane (CH_4) are often expressed as the equivalent units in CO_2 in terms of their global warming potential in 100 years: N_2O has 296 times the warming potential of CO_2 and CH_4 23 times.
[2] Greenpeace International (2002)
[3] Brown and Funk (2008).
[4] Schmidhuber and Tubiello (2007).
[5] Parry *et al* (2007).
[6] Kotschi (2007); Morton (2007); Brown and Funk (2008); Lobell *et al* (2008).
[7] Morton (2007).

burgeoning population let alone provide food to the world will largely depend on whether deep cuts in global GHG can be achieved in the timeframe required to avoid dangerous climate tipping points. To give an even chance of avoiding these climate feedback triggers, global average warming must be kept to well below 2 degrees compared to pre-industrial levels.

To be able to meet this objective, it is essential to global food security, biodiversity protection and regional and rural economic and social well being that global GHG peak and decline well before the end of the decade and ideally by 2015. For the global climate change mitigation effort to succeed in these goals it is imperative that all economic sectors contribute to GHG reductions.

While agriculture, forestry and land use are significant sources of GHG, the single largest and most rapidly increasing GHG source is the Energy Sector. The Australian agriculture, forestry and land use sectors must accept responsibility for their GHG, along side those of the Energy Sector. Mechanisms to generate credits from one sector to offset emissions in another risk forestalling the economic transition required to meet stringent climate protection objectives.

Indeed, to allow energy GHG to increase beyond stringent mitigation targets through trading with emission reductions or sequestration from agriculture, forestry and land use risks increasing global emissions unless measures are taken to overcome issues of impermanence, additionality, uncertainty of accounting and leakage.

For the CFI to be effective in mitigating climate change there must also be an acceptance that adaptation will be a necessary component. Building climate resilience into our ecosystems and food production systems requires long-term planning and a commitment to the provision of large and sustained financial flows. Carbon trading is only one method of achieving these flows, and on many grounds is the least effective.

With a pending price on carbon a more robust method of providing funding for GHG mitigation in the agriculture, forestry and land use sector, maximizing biodiversity and farm productivity co-benefits and building climate resilience into the Australian landscape is to set aside an adequate percentage of the revenue raised from a carbon price for this purpose.

Greenpeace recommends that the Government gives adequate time to develop the CFI process so that sufficient consideration can be given to addressing all the issues and pitfalls likely to emerge from a hastily and ill-conceived offset mechanism.

Indeed Greenpeace is disappointed that *Draft Guidelines for Submitting Methodologies for the CFI* and even of more concern, the *Exposure Draft Of the Carbon Credits (Carbon Farming Initiative) Bill 2011* have been released before any consideration of comments on *Design of the CFI* has been made.

While we accept that time is of the essence in securing a carbon price in Australia, we believe that further consultation is needed before the CFI can usefully contribute to mitigating Global Warming in Australia.

Climate change impacts on Australian agriculture

The IPCC 4AR notes that that short-term natural extremes, such as storms and floods, interannual and decadal climate variations, as well as large-scale circulation changes, such as the El Niño Southern

Oscillation (ENSO), all have important effects on crop, pasture and forest production.[8] For example, El Niño-like conditions increase the probability of farm incomes falling below their long-term median by 75% across most of Australia's cropping regions, with impacts on gross domestic product (GDP) ranging from 0.75 to 1.6%.[9]

Increases in precipitation extremes are very likely in the major agricultural production areas in East Australia[10] and declines in water availability are projected to affect some of the areas currently suitable for rain-fed crops in sub-tropical regions of Australia.[11] Recent findings from IPCC[12] also show projected declines in rainfall in some major Australian grassland and rangeland areas.

The Murray-Darling Basin which accounts for about 70% of irrigated crops and pastures[13] is likely to see annual streamflow fall 10-25%by 2050 and 16-48%by 2100.[14] Little is known about future impacts on groundwater in Australia.

Australian grain quality is likely to be affected by Global Warming. Elevated $CO2$ reduces grain protein levels.[15] Significant increases in nitrogenous fertiliser application or increased use of pasture legume rotations would be needed to maintain protein levels.[16] There is also an increased risk of the development of undesirable heat-shock proteins in wheat grain in both northern and southern cropping zones with temperature increases greater than 4°C .[17]

Land degradation is also likely to be affected by climate change. Elevated atmospheric $CO2$ concentrations slightly reduce crop evapotranspiration.[18] This increases the risk of water moving below the root zone of crops (deep drainage), potentially exacerbating three of Australia's most severe land degradation problems across agricultural zones: waterlogging, soil acidification and dryland salinity.[19]

The spread of animal diseases and pests from low to mid-latitudes due to warming, a continuance of trends already under way, will further impact on food production. Models project that bluetongue, which mostly affects sheep, would spread from the tropics to mid-latitudes.[20] Simulations under climate change also show increased vulnerability of the Australian beef industry to the cattle tick (*Boophilus microplus*).[21]

Design of the CFI

The objective of the CFI must be to reduce emissions from the Australian Agriculture and Land Sector, rather than merely to ensure certainty of rules for crediting and selling carbon offsets.

---

[8] Tubiello (2005).
[9] O'Meagher (2005).
[10] Christensen *et al* (2007).
[11] IPCC (2007c).
[12] IPCC (2007b).
[13] MDBC (2006).
[14] IPCC (2007c).
[15] Sinclair, *et al* (2000).
[16] Howden *et al* (2003).
[17] Howden, *et al* (1999).
[18] IPCC (2007).
[19] *ibid*.
[20] Anon (2006); van Wuijckhuise *et al* (2006).
[21] White *et al* (2003).

It is recognised that incentives for reducing emissions in the Australian Land Sector are necessary. How incentives are provided will be crucial to the success of this effort. Helping land managers in reducing GHG emissions requires a planned process to identify those areas that will lead to sustained GHG mitigation, increase farm productivity, reduce costs and promote ecological sustainability and biodiversity protection. GHG mitigation under the CFI must adhere to the five fundamental requirements as outlined in the Kyoto Protocol and universally accepted, as being; real, measurable, additional, long-term and verifiable.

Any process that fails to meet all these criteria will not deliver the necessary incentives that will unlock the required mitigation and co-benefits essential to meeting public policy objectives.

It is encouraging that the Government recognises that many of the issues unique to the Land Sector have yet to be fully explored. Learning from the past experiences of existing markets and mechanisms will help to avoid the many pitfalls Land Sector offsets represent.

3.1 Existing mechanisms and markets

Existing GHG markets and mechanisms that create offset certificates or market instruments can be divided into compliance regimes such as under the Kyoto Protocol - including the Clean Development Mechanism (CDM) and Joint Implementation (JI) - the EU ETS, the NSW Greenhouse Gas Reduction Scheme (GGAS) and potentially an Australian ETS, and voluntary programs such as the Voluntary Carbon Standard (VCS), the Chicago Climate Exchange (CCX) or the developing National Carbon Offset Standard (NCOS).[22]

GHG programs can also be divided into allowance-based and project-based certificates. Allowance-based instruments involve cap and trade schemes, where permits generally correspond to a tonne of GHG, such as a Kyoto Protocol Assigned Amount Unit (AAU), European Union Allowance (EUA) and CCX's Carbon Financial Instrument (CFI)[23]. Project-based instruments involve baseline and credit schemes, where credits correspond to the reduction of a tonne of GHG in the atmosphere, such as GGAS NSW Greenhouse Gas Abatement Certificates (NGACs), CDM Certified Emission Reductions (CERs) and CCX offsets.[24][25]

The Government appears to be intending the CFI to be a project based mechanism that has both compliance and voluntary market application.

Project based mechanisms have not been successful to date and voluntary markets have a chequered history.

3.2 Adaptation

It will be important for Australia to begin to build resilience against climate impacts into its landscape. The CFI could be used to begin such a task.

Diversity farming is the single most important modern technology to achieve food security in a changing climate.[26]Scientists have shown that diversity provides a natural insurance policy against major ecosystem changes, be it in the wild or in agriculture.[27]It is now predicted that genetic diversity will be most crucial in

---

[22] Balatbat *et al* (2010).
[23] Each CFI instrument is equivalent to 100 metric tons of CO_2 of either exchange allowances or exchange offsets.
[24] In cap and trade scheme a baseline may be used to set the reduction target. For example, CCX members set their emissions reduction targets against their baseline emissions.
[25] Balatbat *et al* (2010).
[26] Greenpeace International (2008).
[27] McNaughton (1977); Chapin *et al* (2000); Diaz *et al* (2006).

highly variable environments and those under rapid human-induced climate change.[28]

The larger the number of different species or varieties present in one field or in an ecosystem, the greater the probability that at least some of them can cope with changing conditions.[29]Species diversity also reduces the probability of pests and diseases by diluting the availability of their hosts. [30] It is an age-old insurance policy of farming communities to hedge their risks and plant diverse crops or varieties.[31]

The strategy is not to maximise yield in an optimum year, but to maximise yield over years, good and bad, by decreasing the chance of crop failure in a bad year. [32]

However, to change Land Sector management, land managers need to be convinced that the climate changes are real and are likely to continue.[33] Managers also need to be confident that the projected changes will significantly impact on their enterprise.[34] Convincing the Agricultural Sector of the risks of climate change remains an outstanding challenge for both government and NGOs. Merely providing opportunities for the agricultural sector will not fully meet this challenge.

Where there are major industry location changes and migration, there may be a role for governments to support these transitions via direct financial and material support, creating alternative livelihood options. These include reduced dependence on agriculture, supporting community partnerships in developing food and forage banks, enhancing capacity to develop social capital and share information.[35]Effective planning for and management of such transitions may also result in less habitat loss, less risk of carbon loss [36] and also lower environmental costs such as soil degradation, siltation and reduced biodiversity.[37]

The capacity to make continuing adjustments and improvements in adaptation by understanding what is working, what is not and why, via targeted monitoring of adaptations to climate change and their costs and effects is essential.[38]

As policy-based adaptations to climate change will interact with, and depend on natural resource management, human and animal health, governance and political rights, among many others, the 'mainstreaming' of climate change adaptation into policies intended to enhance broad resilience will be an important consideration.[39]

3.3 Agriculture emissions

It is important to note that in 2008, the Australian Energy Sector accounted for 75.8 per cent of total GHG emissions, rising from 289Mt in 1990 to 417Mt in 2008, a staggering increase of 44 per cent.[40] This is the fifth highest increase in this sector in the developed world. Australian total emissions in the absence of

[28] Reusch *et al* (2005); Hajjar *et al* (2008); Hughes *et al* (2008).
[29] Greenpeace International (2008).
[30] Chapin *et al* (2000),
[31] Greenpeace International (2008).
[32] Altieri (1990).
[33] Parson *et al* (2003).
[34] Burton and Lim (2005).
[35] IPCC (2007c).
[36] Goklany (1998).
[37] Stoate (2001).
[38] Perez and Yohe (2005).
[39] IPCC (2007c).
[40] FCCC/ARR/2010/AUS.

mitigation policies and measures are projected to reach 622 Mt (excluding LULUCF) in 2020,[41] a 48 per cent increase since 1990.

In comparison, in 2008 emissions from the Australian Agriculture Sector accounted for 15.9 per cent of total GHG or 87 Mt, an increase of 0.7 per cent since 1990.[42] This is also the fifth highest increase in the developed world, though only Canada, USA, New Zealand, Spain and Liechtenstein increased emissions from agriculture over this period.

Agriculture emissions are listed in Annex A of the Kyoto Protocol (KP). Therefore Australia's emission reduction commitment applies to these sources and gases. The Kyoto Protocol defines Agricultural emissions in Annex A [43]as;

- Enteric fermentation,
- Manure management,
- Rice cultivation,
- Agricultural soils,
- Prescribed burning of savannas,
- Field burning of agricultural residues,
- Other.

Excluding savanna burning, agriculture emissions represented 13 per cent of Australia's total greenhouse gas emissions and at 75.1 Mt were 6 per cent below 1990 emissions of 80.2 Mt.[44] In 2020 GHG from agriculture is expected to be 87Mt, and increase of 7.5 per cent on 1990 levels.

The key drivers for the rise in emissions from the Australian Agricultural Sector are strong growth in the more intensive industries such as feedlot cattle and poultry, an increase in the use of synthetic fertilizers and an increase in savanna burning (largely driven by climate cycles).[45]

Within the sector, 63.6 per cent of the emissions were from enteric fermentation, followed by 16.7 per cent from agricultural soils, 15.6 per cent from the prescribed burning of savannas and 3.8 per cent from manure management. The remaining 0.3 per cent was from the field burning of agriculture residues and rice cultivation.[46]

Livestock emissions include enteric fermentation, manure management and the animal production component of agricultural soils accounts for 85 per cent of Agriculture emissions, with the largest component, cattle, accounting for 73 per cent of livestock emissions. Sheep account for a further 18 per cent.

3.4 Land Use and Land Use Change and Forestry emissions

Under the Kyoto Protocol, Land Use and Land Use Change and Forestry (LULUCF) are accounted for differently than all other emission sectors. This is largely due to the fact that some LULUCF activities

[41] Department of Climate Change (2009),
[42] FCCC/ARR/2010/AUS.
[43] These are emissions for which Australia must account under international law, and whose emission reduction targets or quantified emission limitations and reductions objectives (QELRO) apply.
[44] Department of Climate Change (2009).
[45] FCCC/ARR/2010/AUS.
[46] *ibid.*

sequester CO_2, and all have issues of uncertainty and inter annual variability, impermanence and natural disturbances that plague accurate, precise accounting and secure mitigation in the sector.

LULUCF is broken down into Article 3.3 and Article 3.4 activities. Accounting for Article 3.3 activities is mandatory for all countries listed on Annex B of the Protocol ("developed countries").

Article 3.3 includes Land Use Change activities - deforestation, afforestation and reforestation. Accounting for Article 3.4 activities is voluntary and includes forest management, cropland management, grassland management and revegetation. Australia did not elect to account for Article 3.4 activities for the first commitment period. These emissions are however, reported to the UNFCCC, albeit under a different set of categories (IPCC, 2006) than under the KP (IPCC, 1996)

In 2008, reported net emissions from the LULUCF sector amounted to 68.5 Mt
or 11.2 per cent of total GHG emissions in Australia. Since 1990, net emissions have increased by 48.6 per cent. GHG net emissions by sources and removals by sinks in the LULUCF sector displayed high inter-annual variability and shifted between being a net sink and a net source. The key driver for this trend in the LULUCF Sector is primarily the inter-annual climate variability and natural disturbance such as fire and drought.

Within the sector, 188 Mt of emissions were from grassland. Emissions were offset by removals of 104 Mt from forest land and 12 Mt from cropland. The remaining 3.5 Mt was from harvested wood products and agricultural lime application.

Deforestation emissions and Aforestation/Reforestation and Revegetation removals are included in these categories as forest land converted to cropland and grassland and cropland and grassland converted to forest land sun c categories.

Coverage of the CFI

The CFI intends to cover the following agriculture and LULUCF mitigation sources;

a. reforestation and revegetation
b. reduced methane emissions from live stock
c. reduced fertiliser emissions
d. manure management
e. reduced emissions or increased sequestration in agricultural soils (soil carbon)
f. savanna fire management
g. avoided deforestation
h. burning of stubble/crop residues
i. reduced emissions from rice cultivation
j. reduced emissions from land fill waste deposited before 1 July 2011.

a. Reforestation and revegetation –LULUCF (Kyoto compliant)

These LULUCF offset activities are defined by the Marrakech Accord as;

- **Reforestation** - the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989;

- **Revegetation** - a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained here;

In 2008, Australia reported to the UNFCCC that almost -17 Mt was sequestered by Aforestation and Reforestation activities under Article 3.3 of the KP,[47] up from -2 Mt in 1990.[48] Australia does not report any removals by Revegetation activities.

The Garnaut Review identified a potential for 250Mt pa of CO2 removal for several decades from restoration of Mulga - which would meet the revegetation definition. The Garnaut review further suggested that 50Mt pa could be removed from the atmosphere from plantations by 2020 and 143Mt pa of removals by carbon farming plantations for 20 years. [49]

While the abatement potential from activities such as reforestation and revegetation is high, if poorly implemented could threaten ecological processes and risk further biodiversity loss.[50] Reforestation and revegetation in the form of the planted monoculture or mixed species for carbon or for biofuels can lead to highly simplified industrial landscapes with low biodiversity.[51] Such industrial landscapes have poor biodiversity outcomes as they do not provide the space and opportunities for natural ecosystems to self-adapt and reorganize, and deny the maintenance of fundamental ecosystem processes that underpin vital ecosystem services.[52]

Greenpeace recommends that any Reforestation and Revegetation projects be restricted to ecological restoration with mixed planted native vegetation and forest species that reflect regional and local ecological communities.

b. Reduced methane emissions from stock

In 2008, enteric fermentation emitted 56Mt (10.1 per cent of national total emissions).[53] In 2020, GHG from enteric fermentation (methane) from livestock is expected to remain at 1990 levels. This is due to projected reductions in emissions from dairy cattle and sheep offset by a 30 per cent increase in beef cattle GHG.[54]

In 2008, Australia's methane (CH4) emissions represented 21.1 per cent of total GHG (excluding LULUCF). Globally, livestock is the most important anthropogenic source of methane emissions.[55] Methane is a powerful GHG with ~20 times the global warming potential of CO2 and is the second most important GHG having contributed about 24% enhanced greenhouse effect to date.[56] Although the concentration of methane in the atmosphere is much less than that of CO2 (less than 2 ppm), its greenhouse effect is far greater, as the enhanced greenhouse effect caused by a molecule of methane is about 8 times that of a molecule of CO2, but the average lifetime in the atmosphere is about 12 years, much shorter than the

47 FCCC/ARR/2010/AUS.
48 Commonwealth of Australia (2009).
49 Garnaut (2008).
50 Steffen *et al* (2009).
51 Hartley (2002); Sayer *et al* (2004); Marcot (2007); Keenan *et al* (2009).
52 Steffen *et al*. (2009).
53 FCCC/ARR/2010/AUS.
54 Department of Climate Change (2009).
55 US-EPA (2006).
56 Houghton (2005).

lifetime of CO_2.[57]

The amount of methane emitted by animals is directly related to the number of animals, so that a more intensive farm will have higher emissions, though the emissions per unit of product (e.g. meat, milk) might be lower.[58] There are considerations when comparing intensive versus non-intensive livestock production, not least animal welfare issues.

However, the demand for meat products determines the number of animals that need to be raised. An intensive farm may spare land for other purposes by optimising yield on high quality land and, hence, minimising the area that is used for agriculture.[59] It is argued that using less land directly for agriculture will still have an effect on surrounding lands due to high concentrated emissions and different requirements to the infrastructure.[60]

Furthermore, the length of time it takes to rear an animal has decreased dramatically in intensive farming systems (e.g. from 72 days in 1960 to 48 days in 1995 for broiler chickens).[61] Generally, chickens and pigs use concentrated feed (high protein) more efficiently compared to cattle, which enabled a considerable reduction in the rearing time. As a result, the production of these meats has also increased.[62]

Given that the demand of meat has to be met, intensive farming reduces the time necessary to produce the same quantity of product, hence reducing GHG emissions per unit of product. Furthermore, the increase in the production of chickens and pigs may also be favourable considering that these animals produce much less GHG (pig: 1 – 1.5 kg CH_4 head pa) by enteric fermentation compared to cattle (dairy cattle: 36 – 100 kg CH_4 head pa) and sheep (5 – 8 kg CH_4 head pa).[63]

A vegetarian diet produces much less GHG over a lifetime. Substituting just 5% of the meat in the diet with vegetarian products amounts to a reduction of between 95 and 126 g of CO_2 per person per day.[64] For individuals wishing to reduce their GHG footprint, adopting a vegetarian diet, or at least reducing the quantity of meat products in the diet, would have beneficial GHG impacts.

Greenpeace recommends that reducing GHG from enteric fermentation be a high priority of the CFI.

c. Reduced fertilizer use

In 2008, this category emitted 14.5 Mt (2.6 per cent of national total emissions). [65] Agricultural soils are estimated to emit 17Mt of GHG in 2020, an increase of 30 per cent on 1990 levels.[66]

Agricultural soils include;

- synthetic fertilizers and animal waste applied to soil,
- leaching and run-off,

[57] *ibid.*
[58] IPCC (2007d).
[59] Mooney *et al* (2005); Dorrough *et al* (2007).
[60] Matson and Vitousek (2006).
[61] Greenpeace International (2007).
[62] Naylor *et al* (2005).
[63] US-EPA (1998).
[64] Greenpeace International (2007).
[65] FCCC/ARR/2010/AUS.
[66] Department of Climate Change (2009).

- N-fixing crop,
- crop residues and cultivation of histosols, and
- atmospheric deposition.

Generally, fertiliser production has a potential to reduce its global GHG emissions by more than half from 283 Mt to 119 Mt.[67] Improvements would be related to greater energy efficiency in ammonia plants (29%), introduction of new nitrous oxide reduction technology (32%) and other general energy-saving measures in plants (39%).[68]

The reduction of the reliance on fertilisers by adopting cropping systems that maintain high yields has a high mitigation potential.[69] An important example is the use of rotations with legume crops.[70] This reduces the requirement of external N inputs although legume-derived N can also be a source of N2O.[71] This approach is usually acquired by organic practices.[72]

Nitrogen applied in fertilisers (but also other input such as manures) is not always used efficiently by crops. [73] The surplus N is particularly susceptible to emission of N2O.[74] Consequently, improving N use efficiency can reduce N2O emissions and indirectly reduce GHG emissions from N fertiliser manufacture.[75] By reducing leaching and volatile losses, improved efficiency of N use can also reduce off-site N2O emissions.[76] Practices that improve N use efficiency include:

- adjusting application rates based on precise estimation of crop needs (e.g., precision farming);
- using slower controlled-release fertiliser forms or nitrification inhibitors (which slow the microbial processes leading to N2O formation);
- applying N when least susceptible to loss, often just prior to plant uptake (improved timing);
- placing the N more precisely into the soil to make it more accessible to crops' roots;
- avoiding N applications in excess of immediate plant requirements [77]

Organic field crops and animal products generally consume less primary energy than non-organic counterparts, owing in part to the use of legumes to fix N rather than fuel to make synthetic fertilisers.[78] Similarly, the introduction of leguminous species into grassland will increase the productivity or reduce the amount of fertiliser that is required.[79]

Greenpeace supports incentives being provided to reduce Nitrogen usage and recommends that organic farm practices be incentivised as part of the CFI.

d. Manure management

---

[67] Greenpeace International (2007).
[68] Kongshaug (1998).
[69] Paustian *et al* (2004).
[70] West and Post (2002); Izaurralde *et al* (2001).
[71] Rochette and Janzen (2005).
[72] Greenpeace International (2007).
[73] Galloway *et al* (2003); Cassman *et al* (2003).
[74] McSwiney and Robertson (2005).
[75] Schlesinger (1999).
[76] Greenpeace International (2007).
[77] Robertson (2004); Dalal *et al* (2003); Paustian et al (2004); Cole *et al* (1997); Monteny *et al* (2006);
[78] Williams *et al* (2006).
[79] Sisti *et al* (2004); Diekow *et al* (2005); Soussana *et al* (2004).

In 2008, manure management amounted to 3.8 per cent of total national emissions (excluding LULUCF).[80] GHG from manure management is projected to be twice 1990 levels by 2020 at 4 Mt.[81]

There are several ways of managing animal manure, which can either be stored wet (e.g. slurry) or dry (e.g. farm yard manure).[82] Methane emissions occur mainly when the manure is managed in liquid forms (lagoon or holding tanks) or remain wet.[83] Generally, intensive livestock systems use liquid manure management due to the large quantity of manure produced and the method of collection.[84]

A typical system for large-scale pig operations is lagoons (although not in Europe). Manure deposited on fields and pastures or otherwise handled in dry form do not produce significant amounts of methane.[85]Emissions also depend on the animal's diet: Higher energy feed produces manure with more volatile solids, i.e. decomposable organic matter that may emit more GHG depending on surrounding environmental conditions.[86]

Pig production produces the largest share of manure, followed by dairy.[87] If the liquid manure is used for methane production (biogas plants) that is used for energy to replace fossil fuels then the net GHG emissions could be significantly less for pig production than ruminant production.[88]

Greenpeace supports incentives to reduce emissions from manure management and recommends that incentives be provided to the development of regional biogas plants for beneficial use methane production.

e. Soil carbon reduced emissions or increased sequestration in agricultural soils - LULUCF (non-Kyoto compliant)

Reducing emissions and increasing sequestration from soil carbon is defined as cropland and grassland management under Article 3.4 (LULUCF) of the KP. Australia has not elected to account for these activities for the first commitment period (2008-2012),[89] and is unlikley to do so for the second commitment period (post 2012). It must therefore be undertaken under a voluntary carbon scheme or JI.

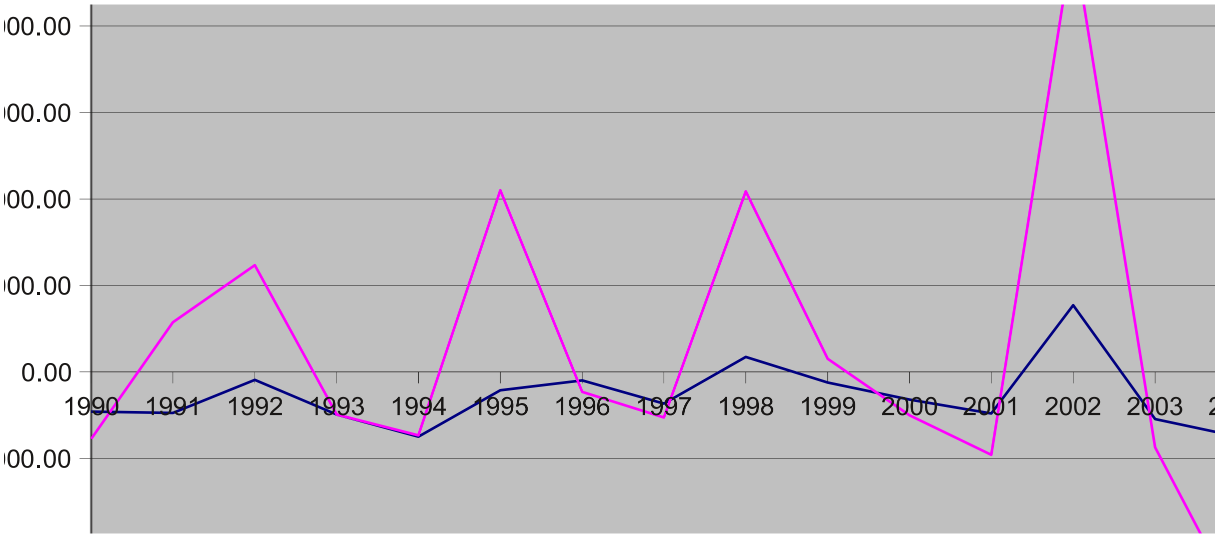
In 2008, Australia reported GHG emissions from grasslands remaining grasslands – similar to grassland management – to be 138Mt, an increase from 1990 when this category was a net sink, sequestering almost -16Mt.

In 2008, Cropland remaining croplands was reported by Australia as a net sink of -19Mt, an increase in the sequestration in 1990 of -16Mt.

Both these reported emissions and removals fluctuate significantly from year to year. As such it is difficult to identify a trend. However, grasslands appear to be an increasing emission source since 1990.

---

[80] FCCC/ARR/2010/AUS.
[81] Department of Climate Change (2009).
[82] Greenpeace International (2007).
[83] *ibid.*
[84] Reid *et al* (2004).
[85] *ibid.*
[86] Greenpeace International (2007).
[87] Steinfeld *et al* (2006).
[88] Greenpeace International (2007).
[89] Only Canada elected to account for cropland managament for the 1st CP of the KP.



Data UNFCCC reported Grassland remaining Grasslands and croplands remaining croplands - http://unfccc.int/di/DetailedByParty.do

Soil disturbance by tillage aerates the soil which enhances microbial decomposition, and hence the loss of carbon. The traffic by machinery or livestock and the tillage will also lead to soil erosion and compactions and poor drainage. These disturbances can be reduced by minimal (conservation till) or no till (NT) practices and less intensive grazing. [90] The carbon benefits from no-till agriculture may be offset, however, by increasing reliance in herbicides and machinery (both practices contribute to GHG emissions) and may affect biodiversity negatively.[91]

However, for organic systems some preliminary study results showed that reduced tillage without the use of herbicides has positive benefits for carbon sequestration in the soil.[92]

No-tillage (NT) management has been promoted as a practice capable of offsetting greenhouse gas (GHG) emissions because of its ability to sequester carbon in soils. However, true mitigation is only possible if the overall impact of NT adoption reduces the net global warming potential (GWP) determined by fluxes of the three major biogenic GHGs (i.e. CO_2, N_2O, and CH_4). [93] Recent studies indicate a strong time dependency in the GHG mitigation potential of NT agriculture, demonstrating that GHG mitigation by adoption of NT is much more variable and complex than previously considered, and policy plans to reduce global warming through this land management practice need further scrutiny to ensure success.[94]

Greenpeace supports Increased soil sequestration through measures such reducing pesticide and fertiliser use but use of those initiatives in a carbon trading or offset system is flawed because of the lack of permancence and the uncertainty of accounting methodologies.

In addition, calculations of net global warming potential relating to proposed systems of alternative crop management are particularly important in relation to claims that Genetically Engineered (GE) cropping systems can increase soil carbon sequestration due to reduced pesticide use. Studies produced by non-biotech sources using US Department of Agriculture data indicate that GE farming methods have greatly increased US farmers' reliance on pesticides, resulting in a 318.4 million tonne increase in pesticide use in

[90] Greenpeace International (2007).
[91] CBD Technical series no. 10.
[92] Greenpeace International, 2007.
[93] Six *et al* (2004).
[94] *ibid.*

the first 13 years of commercial use. [95]

Greenpeace supports incentives to to reduce emissions from agricultural soils, but is opposed to crediting of sequester GHG by agricultural soils at this stage.

GHG reporting concerns

Australia chose 50 years as the transition period for land-use conversion but this was not fully applied in its disaggregation of land use into the land-use remaining and land-use conversion subcategories, which is inconsistent with the IPCC good practice guidance for LULUCF.[96]

Therefore, all the lands that were cropland or grassland prior to 1972 are reported in the categories cropland remaining cropland and grassland remaining grassland, respectively. The conversion categories include only forestland converted to cropland or to grassland after 1972, leading to a variable land conversion period from 18 years for 1990 to 36 years for 2008, which is also inconsistent with the IPCC good practice guidance for LULUCF. [97] During the review, Australia explained that precise information on the conversion of land prior to 1972 is not available.

f. Savanna burning

In 2008, this category emitted 13.Mt (2.5 per cent of national total emissions) and was 96 per cent above 1990 emissions of 6.6 Mt. Emissions in 2020 are projected to be 12.4 Mt.

Savanna emissions arise from deliberate ignition by land managers or as a result of wildfires. The largest areas burnt are in the Northern Territory, Western Australia and Queensland. Fire scars mapped in 2001 identified late-season fires covered 40.4 million hectares of tropical savanna in Northern Australia.[98]

Emissions arising from savanna burning depend on a number of factors including the area under fire management, the mass of fuel available from the previous season's growth, climatic conditions such as temperature and rainfall, and the timing of fires within the dry season.[99]Of these factors, the most important driver appears to arise from the relationship between rainfall and the accumulation of fuel loads. It is difficult to project savanna burning emissions based on rainfall as reliable long term rainfall projections are not readily available.[100]

Tropical savannas can be remarkably productive, with a net primary productivity that ranges from 1 to 12 t C per hectare per annum.[101] The lower values are found in the arid and semi-arid savannas occurring in extensive regions of Northern Australia. If savannas were to be protected from fire and grazing, most of them would accumulate substantial carbon and the sink would be larger. Savannas are under anthropogenic pressure, but this has been much less publicized than deforestation in the rain forest biome. The rate of loss is not well established, but may exceed 1% per year, approximately twice as fast as that of rain forests.[102]

---

[95] Benbrook (2009)
[96] FCCC/ARR/2010/AUS.
[97] *ibid*.
[98] http://savanna.cdu.edu.au/research/fr_fire_savannas.html
[99] Department of Climate Change (2009).
[100] *ibid.*
[101] Grace *et al* (2006).
[102] *ibid,*

Folke *et al* (2004) suggets that periods of drought with high stock numbers bring about the death of perennial grasses and lead to reduced grass cover. When followed by good rains this reduced grass cover, in turn, leads to a profusion of woody seedlings. If, at this point, all livestock were removed, enough grass growth would still occur to enable an effective fire and keep the system in a grassy state. However, if grazing pressure is sustained a point is reached in the increasing woody:grass biomass ratio after which, even if all livestock are removed, the competitive effect of the woody plants is such that it prevents the build up of sufficient grass fuel to sustain a fire. The system then stays in the woody state until the shrubs or trees reach full size and, through competition among them, begin to die. The vegetation then opens up for the reintroduction of grass and fire. This process can take 30 or 40 years.[103]

Greenpeace supports incentives to reduce GHG from savanna burning.

g. Deforestation – LULUCF (Kyoto compliant)

Australian forests cover 149 million hectares (24% of the land area); 147 million hectares of native forests and nearly 2 million hectares of forest plantations.[104]About 70% of Australian forests are under private ownership or management through long-term lease arrangements.[105] Between 1990 and 2010, Australia lost 3.4% of its forest cover, or around 5,200,000 ha.[106]

In 2008 emissions from deforestation were reported at 49.65Mt.[107]Over the period from 2013 to 2020, projected emissions from the deforestation increase slightly from 47 Mt to 49 Mt per annum.[108] In 1990, deforestation emissions were 132Mt.

Much of the reductions in deforestation emissions have been non-additional. In other words they would have occurred regardless of the Kyoto Protocol and any policies and measures intended to meet the emission reduction targets to which Australia agreed.

During the Kyoto Protocol negotiations Australia requested that deforestation emissions be included in its base year (1990) because these emissions had fallen by approximately 50 per cent over the period 1990 to 1997.[109] Including deforestation emissions in its base year would allow Australia to receive credit for reductions that had already occurred and offset emission increases in other sectors during the first commitment period, 2008 to 2012.[110] The ability to include deforestation emissions in its base year will give Australia an 'offset' worth
about 60 to 100 Mt per annum during the first commitment period.[111]

Broadscale remnant clearing in Queensland was addressed on 31 December 2006 under the Queensland Government's vegetation management legislation and the NSW Government commenced legislation applying additional restrictions on clearing of remnant and protected regrowth vegetation in December 2005.[112]While preliminary NCAS assessment found that the area of land subject to first time conversion in

[103] Folke *et al* (2004).
[104] MIG (2008).
[105] Keenan (2009).
[106] FAO (2009).
[107] FCCC/ARR/2010/AUS.
[108] Department of Climate Change (2009).
[109] Hamilton and Vellen (1999).
[110] Macintosh (2010).
[111] Department of Climate Change (2009),
[112] *ibid,*

2007 in Queensland was around 96,000 hectares, significantly lower than the levels in the previous years, results for NSW assessments do not show a reduction in emissions in during the initial twelve month period following the commencement of the vegetation management reforms. [113]

Greenpeace supports incentives being provided to reduce deforestation emissions. However, has significant concern for the transparency and accuracy of emission data for this category.

Greenpeace recommends that the eventual CFI legislation specifically exclude non-human induced reforestation from any crediting.

GHG reporting concerns

Australia has been questioned on aspects of it deforestation emissions reporting to the UNFCCC. For example there was a systematic reduction of the area of forest land remaining forest land and a significant change in the area of land conversion to and from forest land. However, this was not fully documented in the NIR. The UNFCCC Expert Review Team recommended that Australia increase the transparency of its recalculations by describing any significant changes associated with its recalculations in the next annual submission.[114]

It is a concern that that significant changes in deforestation emissions that increased its base year emissions have not been explained in Australia's National Inventory Report.

h. Burning of stubble/crop residues

In 2008, Field Burning of Agricultural Residue accounted for 0.282 Mt down from 0.29Mt in 1990.[115]

Systems that retain crop residues also tend to increase soil carbon because these residues are the precursors for soil organic matter, the main carbon store in soil. Avoiding the burning of residues (eg mechanising sugarcane harvesting, eliminating the need for pre-harvest burning),[116]also avoids emissions of aerosols and GHGs generated from fire, although CO2 emissions from fuel use may increase.[117]

Greenpeace supports incentives to reduce emissions from Field Burning from Agricultural Residues.

i. Reduced emissions from rice cultivation

In 2008, GHG emissions from rice cultivation was only 0.043Mt, down from 0.490Mt in 1990. However, a great deal of fluctuation exists for this category. For example in 2007 emissions were 0.19Mt.[118]Nevertheless, emissions have been trending down since a peak in 2000 of 0.74Mt.

Cultivated wetland rice soils emit significant quantities of methane.[119]Emissions during the growing season

---

113 *ibid*,
114 FCCC/ARR/2010/AUS.
115 http://unfccc.int/di/DetailedByParty.do
116 Cerri *et al* (2007).
117 IPCC (2007d).
118 http://unfccc.int/di/DetailedByParty.do
119 Yan *et al* (2003).

can be reduced by various practices.[120] For example, draining wetland rice once or several times during the growing season reduces CH4 emissions.[121] This benefit, however, may be partly offset by increased N2O emissions,[122]and the practice may be constrained by water supply.[123]

Rice cultivars with low exudation rates could offer an important methane mitigation option.[124]In the off-rice season, improved water management can reduce methane emissions, especially by keeping the soil as dry as possible and avoiding water-logging.[125]

Increasing rice productivity can also enhance soil organic carbon stocks.[126]Methane emissions can be reduced by adjusting the timing of organic residue additions (e.g., incorporating organic materials in the dry period rather than in flooded periods; [127]by composting the residues before incorporation, or by producing biogas for use as fuel for energy production.[128]

Greenpeace supports providing incentives to reduce emissions from Rice Cultivation

j. Reduced emissions from land fill waste deposited before 1 July 2011

Emissions from Legacy Waste (deposited before 1 July 2011) and emissions from below threshold waste sites are projected to fall from 9.7 Mt in 2013 to 6.8 Mt in 2020, a fall of 30 per cent. This reflects an increasing proportion of emissions in the Waste Sector associated with waste deposited after the Scheme commences.

The White Paper, released in December 2008, recognised that some operators of landfill sites will have difficulties in managing permits liabilities for emissions from past waste streams. In May 2009 the Rudd Government announced that liability for landfill emissions under the Carbon Pollution Reduction Scheme will now only apply to emissions that come from waste that is deposited after 1 July 2011.

The recovery of methane from landfill is a key factor in eliminating these emissions. Methane capture is projected to continue to increase at similar rates to the historical trends, around 2.3 per cent per annum.

Greenpeace supports methane capture from Legacy Waste deposited before 1 July 2011.

Administering NCOS eligible domestic offsets

Kyoto compliant emissions should be the priority of the CFI. Non-Kyoto abatement in the form of Joint Implementation and voluntary markets may help build capacity in the sectors to reduce emissions, but sectors that sequester carbon should be treated with caution.

Carbon trading is fraught with risks and perversities that have been created within even the most

[120] Yagi *et al* (1997); Wassmann *et al* (2000); Aulakh *et al* (2001)
[121] Smith and Conen (2004); Yan *et al* (2003); Khalil and Shearer (2006).
[122] Akiyama *et al* (2005).
[123] Greenpeace International (2007).
[124] Alcock and Hegarty (2006)
[125]Cai *et al* (2000); Cai *et al* (2003); Kang *et al* (2002); Xu *et al* (2003).
[126] Pan *et al* (2006).
[127] Xu *et al* (2000); Cai *et al* (2004).
[128]Wang *et al* (1996); Wassmann *et al* (2000).

considered of trading mechanisms. For example, Balatbat *et al* (2010) suggest that international emissions trading under the Kyoto Protocol has lowered the overall effectiveness of the Kyoto Protocol due to some countries receiving so called 'hot air' - which is tradable and is transferable to other countries through the provided flexibility mechanism. Over the first commitment period, 'hot air' could potentially amount to 8.2 Gt, or 1.6 Gt annually.[129]Because of the Global Financial Crises the volume of 'hot air' may even be higher than predicted. The World Bank predicts around 10 GT excess AAUs over the first commitment period. [130]

A study by Schneider (2007) concluded that for about 40% of the registered CDM projects additionality is unlikely or questionable, and that these projects are expected to generate about 20% of the 93 project's CERs.[131] In addition, some credits generated work as a subsidy and may increase GHG emissions as they create perverse incentive to artificially stimulate new production of GHG in order to generate credits. This is mainly observed for HCFC-22 plants where it is very cheap to install a destruction facility and given their high Global Warming Potential the number of credits is very high.[132]

Most voluntary activities are focused on the renewable sector followed by landfill and forestry projects.[133]The Carbon Offsets Guide Australia indicates that 14 of the 24 Providers of 'forestry' credits create 'non-accredited' offsets that do not correspond to any GHG programme. Therefore the quality of those credits is questionable.[134]

In must be recognised that voluntary markets are speculative by nature as well as profit motivated. While in themselves these aspects may not detract from the mitigation they encourage, they will drive mitigation towards least cost abatement which can lead to sub-prime mitigation unless strict standards are maintained.

It is therefore questionable whether the CFI should be based on a market model. Indeed, a Carbon Farming Fund that is financed through a proportion of the revenue raised from a price on Australian Kyoto compliant emissions would have a far greater chance of success.

Demand for CFI credits

Demand for carbon trading is underpinned by mitigation effort. The EU ETS is driving international carbon trading and although demand is down due to the Global Financial and Economic crises, volume and value of the market has steadily increased over the last three years.[135] This is largely due to the EU having one of the highest mitigation pledges for the Kyoto second commitment period – between 20 and 30% reductions compared to 1990.

If the Australian Government wishes the CFI to operate effectively, it needs to substantially increase its GHG reduction target in order to accord with IPCC recommendations and to ensure the CFI operates effectively through sufficient supply of funding.

---

[129] Jotzo and Betz (2009).
[130] Balatbat *et al* (2010).
[131] Schneider (2007).
[132] Balatbat *et al* (2010).
[133] *Ibid*
[134] *ibid*
[135] *ibid*

Integrity standards

Project-based land sector mitigation is a poor method of GHG abatement, as nation wide GHG reductions cannot be guaranteed. Leakage and additionality cannot be overcome to any satisfactory standard under a project-based Land Sector crediting mechanism.

Balatbat *et al* (2010) suggests that many projects;

- set criteria for determination of the baseline scenario that lack specific detail in the approach options, allowing project developers to choose and have approved poorly justified non-conservative scenarios.
- allow the use of default emission or carbon stock factors that while universally accepted as a reasonable average do not represent conservative factors for many projects. In land use projects especially this can result in substantial over-estimation of GHG reductions in specific circumstances.
- pay inadequate attention to the establishment of clear and sufficiently detailed criteria for the assessment of projects, effectively shifting the responsibility onto reviewers (auditors and expert review panels) with the expectation of expertise that simply does not exist at this time.

Leakage

Balabet *et al* (2010) state; "There is no GHG program in operation at this time that has successfully dealt with leakage, which is a crucial consideration for land use projects. Many projects have been approved that are quite likely to in fact result in an overall increase in emissions. That is if leakage was appropriately considered and evaluated they would never be approved as projects in the first place. The majority of registered (approved) land use projects include statements to the effect of 'we do not believe the project will result in any leakage' which are accepted by validators and program administrators alike, despite having no evidence to back such statements up." [136]

Greenpeace recommends that any CFI crediting be based on State or Territory level mitigation baselines to minimise the risk of leakage. As most land sector legislation and GHG reporting data is gathered from State Government agencies, it is common sense to also define mitigation credits based on State based mitigation effort.

Additionality

Additionality of project mitigation cannot be guaranteed. The CDM Executive have an elaborate process for determining additionality, but have still failed to avoid about 40% of non-additional projects from being approved.[137]

Additionality can be divided into;

- lack of real abatement (where GHG reductions are less than claimed),
- lack of BAU additionality (where the GHG reductions created could reasonably be expected to have occurred regardless), and
- lack of policy additionality (where the GHG reductions occur but are driven by some other

[136] Balatbat *et al* (2010).
[137] see Schneider (2007).

government policy).[138]

GHG crediting, particularly from the Land Sector, can only be successful when it is based on mitigation that has occurred within a defined boundary that is large enough to contribute substantially to overall national reductions.

Greenpeace is opposed to crediting for project based mitigation and recommends that the CFI base any crediting on mitigation that has occurred over an entire State or Territory boundary and against a long-term historical baseline.

Permanence

It is apparent that the permanence issue has been considered in detail in the *Design of the Carbon Farming Initiative Consultation Paper*. All the suggestions for dealing with permanence have considerable merit and would avoid some of the issues inherent in reversals of Land Sector mitigation.

However, a discount factor of 50% on sequestration activities would provide additional security and avoid the risk of increasing GHG should reversals of removals occur. In many cases re-establishing the removal activity will be difficult or impossible, particularly if predicted reductions in rainfall and increase fire intensity and frequency occur in the area of the sequestration activity.

Greenpeace recommends a 50% discount on sequestration credits be imposed to avoid reversals leading to increased GHG emissions.

Conclusion

While it is not at all certain whether a second commitment period of the Kyoto Protocol will be agreed to by the international community, it is likely that most of the Kyoto accounting methodologies and rules will be subsumed or continued within an international instrument in the near future. If this is not the case, or a gap exists between the fist and second commitment period, it will be in Australia's interest to maintain emission reduction targets in line with its international pledges, so as to avoid a lag in emission reductions that may need to be made up for under an eventual international agreement.

Australia has a poor record for emission reductions and needs to make up for its recalcitrance in international climate negotiations during the 1990s. This is evident in Australia's staggering growth in GHG since 1990. In 2008, Australia's total GHG emissions (excluding LULUCF) amounted to 550 million tones (MT), a 31.4 per cent increase since 1990. If all LULUCF emissions are included this figure stands at 618 Mt, an increase of 33 per cent on 1990 levels.[139] That Australia can claim to meet its first commitment Kyoto commitment of 108% of 1990 emissions is only due to distorted Kyoto accounting rules.

The CFI as an opportunity to reduce Australia's Land Sector emissions, improve unsustainable agricultural practices and build climate resilience into our ecosystems and farm productivity. Incentives that address these imperatives are desperately needed

However, a fully fungible scheme that provides incentives to one sector by allowing emissions in another to increase beyond emission reduction targets is flawed. This is particularly so with the Land Sector, where uncertain emission accounting, additionality, leakage and impermanence issues remain largely insurmountable.

[138] see Schneider (2007).
[139] http://unfccc.int/di/DetailedByParty.do

It is clear that the Australian Government is seeking a method of meeting its international GHG mitigation pledges while maintaining our appallingly high levels of fossil fuel emissions, particular from burning coal. Under the unsuccessful CPRS, the Australian Government proposed unlimited international offsets, most likely on Reducing Emissions from deforestation and forest Degradation in the developing world (REDD). It is now clear that a robust and effective REDD mechanism that is acceptable to the international community will not be available for many years, as countries like Indonesia grapple with indigenous and forest dependant community and biodiversity safeguards, institutional and technological capacity, as well as accounting uncertainties, permanence, additionality and leakage issues.

For Australia to meet its international GHG reduction commitments while maintaining its reliance on cheap and dirty coal, it needs a mechanism to offset these fossil fuel emissions on mitigation in another sector. However, this is not in Australia's long-term national interest. It is essential to food security, biodiversity protection and regional and rural economic and social well being that global GHG peak and decline well before the end of the decade and ideally by 2015. For the global climate change mitigation effort to succeed in these goals it is imperative that all economic sectors contribute to GHG reductions.

Greenpeace therefore questions the usefulness of the CFI offset scheme described in the Consultation Paper, and recommends that Australia focus on ensuring Energy emissions peak by 2012 and rapidly decline as soon as possible thereafter while building mitigation and adaptation capacity in the Agriculture and Land sector.

References

Akiyama H., Yagi K. and Yan X. (2005). Direct N2O emissions from rice paddy fields: summary of available data. *Global Biogeochemical Cycles 19.*
Alcock D. and Hegarty R.S. (2006) *'Effects of pasture improvement on productivity, gross margin and methane emissions of a grazing sheep enterprise*.' (Elsevier: The Netherlands).
Altieri, M.A. (1990). Agroecology. In: *Agroecology* (eds Carrol, C.R., Vandermeer, J.H. and Rosset, P.M.) 551–564. McGraw Hill, New York.
Aulakh M.S., Wassmann R., Bueno C. and Rennenberg H. (2001). Impact of root exudates of different cultivars and plant development stages of rice (Oryza sativa L.) on methane production in a paddy soil. *Plant and Soil* 230, 77-86.
Anon (2006): Bluetongue confirmed in France. News and Reports, *Vet. Rec.*, **159**, 331;
Balatbat, M., Betz, R., Passey, R., Baalman, P., (2010). *State and Trend of Carbon Markets: Australian Businesses and Government Involvement.* UNSW Centre for Energy and Environmental Markets and GHG Offset Services. Sydney
Benbrook, C., (2009) Impacts of Genetically Engineered Crops on Pesticide Use: The First Thirteen Years
http://www.organic-center.org/reportfiles/13Years20091126_FullReport.pdf
Brown, M.E., and Funk C.C. (2008). Food security under climate change. *Science* 319: 580-581.
Burton, I. and B. Lim, (2005): Achieving adequate adaptation in agriculture. *Climatic Change*, **70**, 191-200.
Cai Z.C., Tsuruta H. and Minami K. (2000). Methane emissions from rice fields in China measurements and influencing factors. *Journal of Geophysical Research* 105, 17231-17242.
Cai Z.C., Tsuruta H., Gao M., Xu H. and Wei C.F. (2003). Options for mitigating methane emission from a permanently flooded rice field. *Global Change Biology* 9, 37-45.
Cai Z.C. and Xu H. (2004) *'Options for mitigating CH4 emissions from rice fields in China*.' (Tsukuba).
Cassman K.G., Dobermann A., Walters D.T. and Yang H. (2003). Meeting cereal demand while protecting natural resources and improving environmental quality. *Annual Review of Environment and Resources* 28, 315-358.
Cerri C.E.P., Sparovek G., Bernoux M., Easterling W.E., Melillo J.M. and Cerri C.C. (2007). Tropical agriculture and global warming: Impacts and mitigationoptions. *Scientia Agricola* 64, 83-99.
Chapin, F.S., Zavaleta, E.S., Eviner, V.T., Naylor, R.L., Vitousek, P.M., Reynolds, H.L., Hooper, D.U., Lavorel, S., Sala, O.E., Hobbie, S.E., Mack, M.C. and Diaz, S. (2000). Consequences of changing biodiversity. *Nature* 405: 234-242
Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, W.-T. Kwon and Coauthors, (2007): Regional climate projections. *Climate Change 2007: Contribution of Working Group I to the Fourth Assessment Report*

of the Intergovernmental Panel on Climate Change, S. Solomon, D. Q in, and M.Manning, Eds., Cambridge University Press, Cambridge, 847-940.
Cole C.V., Duxbury J., Freney J., Heinemeyer O., Minami K., Mosier A., Paustian K., Rosenberg N., Sampson N., Sauerbeck D. and Zhao Q. (1997). Global estimates of potential mitigation of greenhouse gas emissions by agriculture. *Nutrient Cycling in Agroecosystems* 49, 221-228.
Commonwealth of Australia, (2009). *Land Use, Land-Use Change and Forestry (LULUCF)* Informal Data Submission to the AWGKP, September 2009. http://unfccc.int/files/kyoto_protocol/application/pdf/australialulucf300909.pdf.
Dalal R.C., Wang W., Robertson G.P. and Parton W.J. (2003). Nitrous oxide emission from Australian agricultural lands and mitigation options a review. *Australian Journal of Soil Research* 41, 165-195.
Diekow J., Mielniczuk J., Knicker H., Bayer C., Dick D.P. and Kögel-Knabner I. (2005). Soil C and N stocks as affected by cropping systems and nitrogen fertilization in southern Brazil Ariscol managed under no-tillage for 17 years. *Soil and Tillage Research* 81, 87-95.
Department of Climate Change, (2009*), Tracking to Kyoto and 2020*, August 2009: Australia's Greenhouse Emissions Trends 1990 to 2008-12 and 2020, DCC, Canberra, ACT.
Diaz, S., Fargione, J., Chapin F. S. and Tilman, D. (2006). Biodiversity loss threatens human well-being. *PLoS Biology* 4: 1300-1306.
Dorrough J., Moll J. and Crosthwaite J. (2007). Can intensification of temperate Australian livestock production systems save land for native biodiversity? *Agriculture, Ecosystems and Environment* 121, 222-232.
FAO (2003) *Strengthening coherence in FAO's initiatives to fight hunger* (Item 10). Conference Thirty-second Session, 29 November to 10 December, Food and Agriculture Organization of the United Nations, Rome.
FAO (2009). *State of the Worlds Forest*. Food and Agriculture Organization of the United Nations Rome.
FCCC/ARR/2010/AUS. Report of the individual review of the annual submission of Australia submitted in 2010. http://unfccc.int/resource/docs/2010/arr/aus2.pdf .
Folke, C. , Steve Carpenter, Brian Walker, Marten Scheffer, Thomas Elmqvist, Lance Gunderson, and
Galloway J.N., Aber J.D., Erisman J.W., Seitzinger S.P., Howarth R.W., Cowling E.B. and Cosby B.J. (2003). The nitrogen cascade. *Bioscience* 53, 341-356.
Garnaut, R (2008) *The Garnaut Climate Change Review Final Report*, Cambridge University Press, Port Melbourne.
Grace, J., José, J. S., Meir, P., Miranda, H. S. and Montes, R. A. (2006), Productivity and carbon fluxes of tropical savannas. *Journal of Biogeography*, 33: 387–400.
Greenpeace International (2007). Cool Farming: Climate impacts of agriculture and mitigation potential. Amsterdam. http://www.greenpeace.org/international/en/publications/reports/cool-farming-full-report/.
Greenpeace International (2008). Food Security and Climate Change: The answer is biodiversity
A review of scientific publications on climate change adaptation in agriculture. Amsterdam.
http://www.greenpeace.org/eu-unit/press-centre/reports/food-security-and-climate-change.
Goklany, I.M., (1998): Saving habitat and conserving biodiversity on a crowded planet. *BioScience*, **48**, 941-953.
Hamilton, C and Vellen, L.,(1999) 'Land-use change in Australia and the Kyoto Protocol'. *Environmental Science & Policy* 2: 1999, pp. 145–152.
Hartley, M.J. (2002) Rationale and methods for conserving biodiversity in plantation forests. *Forest Ecol Manage* 155, 81–95.
Hajjar, R., Jarvis, D.I. and Gemmill-Herren, B. (2008). The utility of crop genetic diversity in maintaining ecosystem services. *Agriculture Ecosystems & Environment* 123: 261-270.
Holling, C.S. (2004). Regime Shifts, Resilience, And Biodiversity In Ecosystem Management. *Annual Review of Ecology, Evolution, and Systematics* Vol. 35: 557-581.
Houghton, J. (2005) Global warming. *Rep. Prog. Phys*. **68** (2005) 1343–1403
Howden, S.M., P.J. Reyenga and H. Meinke, (1999): Global change impacts on Australian wheat cropping. CSIROWildlife and EcologyWorking Paper 99/04, Report to the Australian Greenhouse Office, Canberra, 121 pp. http://www.cse.csiro.au/publications/1999/globalchange-99-01.pdf.
Hughes, A.R., Inouye, B.D., Johnson, M.T.J., Underwood, N. and Vellend M. (2008). Ecological consequences of genetic diversity. *Ecology Letters* 11: 609-623.
IPCC (2007b): Climate Change 2007: *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, S. Solomon, D. Q in, M.Manning, Z. Chen, M.Marquis, K.B. Averyt, M. Tignor and H.L.Miller, Eds., Cambridge University Press, Cambridge, 996pp.
IPCC, (2007c): Impacts, Adaptation and Vulnerability. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge University Press, Cambridge, UK, 976 pp.

IPCC (2007d). *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007* . B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
Izaurralde R.C., McGill W.B., Robertson J.A., Juma N.G. and Thurston J.J. (2001). Carbon balance of the Breton classical plots over half a century. *Soil Science Society of America Journal* 65, 431-441.
Jotzo, Frank and Betz, Regina (2009) Australia's emissions trading scheme: opportunities and obstacles for linking, *Climate Policy*, vol. 9, pp. 402–414.
Kang G.D., Cai Z.C. and Feng X.Z. (2002). Importance of water regime during the non-rice growing period in winter in regional variation of CH4 emissions from rice fields during following rice growing period in China. *Nutrient Cycling in Agroecosystems* 64, 95-100.
Khalil M.A.K. and Shearer M.J. (2006). Decreasing emissions of methane from rice agriculture. In *'Greenhouse Gases and Animal Agriculture - An Update'*. The Netherlands. (Eds CR Soliva, J TakashakiandM Kreuzer) pp. 33-41. (Elsevier).
Keenan, R., (2009). *Disturbance, degradation, and recovery: forest dynamics and climate change mitigation* XIII World Forestry Congress Buenos Aires, Argentina, 18 – 23 October 2009.
Keenan, R., Lamb D., Woldring O., Irvine T., Jensen R. (2009) Restoration of plant biodiversity beneath tropical tree plantations in Northern Australia. *Forest Ecol Manage* **99**, 117–131.
Kongshaug G. (1998). Energy consumption and greenhouse gas emissions in fertilizer production. In *'IFA Technical Conference'Marrakech, Marocco*).
Kotschi, J. (2007). Agricultural biodiversity is essential for adapting to climate change. *GAIA - Ecological Perspectives for Science and Society* 16: 98-101.
Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P., and Naylor R.L. (2008). Prioritizing climate change adaptation needs for food security in 2030. *Science* 319: 607-610.
McNaughton, S.J. (1977). Diversity and stability of ecological communities: a comment on the role of empiricism in ecology. *The American Naturalist* 111: 515 –525.
McSwiney C.P. and Robertson G.P. (2005). Nonlinear response of N2O flux to incremental fertilizer addition in a continuous maize (Zea mays L.) cropping system. *Global Change Biology* 11, 1712-1719.
Macintosh, A., (2010). *Reducing emissions from deforestation and forest degradation in developing countries: A cautionary tale from Australia*. Policy Brief No. 12 April 2010.
Matson P.A. and Vitousek P.M. (2006). Agricultural intensification: Will land spared from farming be land spared for nature? *Conservation Biology* 20, 709- 710.
Marcot, B.G. (2007) Biodiversity and the lexicon zoo. *Forest Ecol Manage* **246**, 4–13.
MDBC (2006): *Basin Statistics.* Murray-Darling Basin Commission. http://www.mdbc.gov.au/about/basin_statistics.
MIG (2008). *Australia's State of the Forest Report* 2008. Montreal Imp lementation Group and Bureau of Rural Sciences, Canberra.
Monteny G.-J., Bannink A. and Chadwick D. (2006). Greenhouse gas abatement strategies for animal husbandry. *Agriculture, Ecosystems and Environment* 112, 163-170.
Mooney H., Cropper A. and Reid W. (2005). Confronting the human dilemma. *Nature* 434, 561-562.
Morton, J.F. (2007). Climate change and food security special feature: the impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences* 104: 19680-19685.
Naylor R., Steinfeld H., Falcon W., Galloway J., Smil V., Bradford E., Alder J. and Mooney H. (2005). *AGRICULTURE: Losing the Links Between Livestock and Land* pp. 1621-1622.
O'Meagher, B., (2005): Policy for agricultural drought in Australia: an economics perspective. *From Disaster Response to Risk Management: Australia's National Drought Policy*, L.C. Botterill and D.Wilhite, Eds., Springer, Dordrecht, 139-156.
Pan G.X., Zhou P., Zhang X.H., Li L.Q., Zheng J.F., Qiu D.S. and Chu Q.H. (2006). Effect of different fertilization practices on crop C assimilation and soil C sequestration a case of a paddy under a long-term fertilization trial from the Tai Lake region, China. *Acta Ecologica Sinica* 26, 3704-3710.
Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E., (eds.) (2007). Summary for Policymakers. In: Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, 7-22.
Parson, E.A., R.W. Corell, E.J. Barron,V. Burkett,A. Janetos, L. Joyce, T.R. Karl, M.C. Maccracken and Co-authors, (2003): Understanding climatic impacts, vulnerabilities, and adaptation in the United States: building a capacity for assessment. *Climatic Change*, 57, 9-42.
Paustian K., Babcock B.A., Hatfield J., Lal R., McCarl B.A., McLaughlin S., Mosier A., Rice C., Robertson G.P., Rosenberg N.J., Rosenzweig C., Schlesinger W.H. and Zilberman D. (2004). *Agricultural mitigation of greenhouse gases: science*

and policy options. CAST (Council on Agricultural Science and Technology)R141 2004.
Perez, R.T. and G. Yohe, (2005): Continuing the adaptation process. *Adaptation Policy Frameworks for Climate Change*, B. Lim, E. Spanger-Siegfried, I. Burton, E. Malone and S. Huq, Eds., Cambridge University Press, , 205-224.
Reid R.S., Thornton P.K., McCrabb G.J., Kruska R.L., Atieno F. and Jones P.G. (2004). Is it possible to mitigate greenhouse gas emissions in pastoral ecosystems of the tropics? *Environment, Development and Sustainability* 6, 91-109.
Reusch, T. B. H., Ehlers, A., Hammerli, A. and Worm, B. (2005). Ecosystem recovery after climatic extremes enhanced by genotypic diversity. *Proceedings of the National Academy of Sciences*, 102: 2826-2831.
Robertson G.P. (2004) '*Abatement of nitrous oxide, methane and other non-CO2 greenhouse gases the need for a systems approach*.' Island Press: Washington DC.
Rochette P. and Janzen H.H. (2005). Towards a revised coefficient for estimating N2O emissions from legumes. *Nutrient Cycling in Agroecosystems* 73, 171-179.
Sayer, J., Chokkalingam U., Poulsen J. (2004) The restoration of forest biodiversity and ecological values. *Forest Ecol Manage* **201**, 3–11.
Schlesinger W.H. (1999). Carbon sequestration in soils. *Science* 284, 2095- 2095.
Schmidhuber, J. and Tubiello, F.N.(2007). Global food security under climate change. Proceedings of the National Academy of Sciences 104: 19703-19708.
Schneider, Lambert (2007), Is the CDM fulfilling its environmental and sustainable development objectives? An evaluation of the CDM and options for improvement, Report prepared for WWF, Institute of Applied Ecology, Berlin.
Sinclair, T.R., P.J. Pinter Jr, B.A. Kimball, F.J.Adamsen, R.L. LaMorte, G.W.Wall, D.J. Hunsaker, N.Adam, T.J. Brooks, R.L. Garcia, T. Thompson, S. Leavitt and A. Matthias, (2000): Leaf nitrogen concentration of wheat subjected to elevated [CO2] and either water or N deficits. *Agr. Ecosyst. Environ.*, **79**, 53-60.
Sisti C.P.J., Santos H.P., Kohlmann R., Alves B.J.R., Urquiaga S. and Boddey R.M. (2004). Change in carbon and nitrogen stocks in soil under 13 years of conventional or zero tillage in southern Brazil. *Soil and Tillage Research* 76, 39- 58.
Six, J., Ogle, S. M., Jay breidt, F., Conant, R. T., Mosier, A. R. and Paustian, K. (2004), The potential to mitigate global warming with no-tillage management is only realized when practised in the long term. *Global Change Biology*, 10: 155–160.
Smith K.A. and Conen F. (2004). Impacts of land management on fluxes of trace greenhouse gas. *Soil Use and Management* 20, 255-263.
Soussana J.F., Loiseau P., Viuchard N., Ceschia E., Balesdent J., Chevallierm T. and Arrouays D. (2004). Carbon cycling and sequestration opportunities in temperate grasslands. *Soil Use and Management* 20, 219-230.
Steffen, W., Burbidge A., Hughes L. *et al*. (2009) *Australia's biodiversity and climate change: a strategic assessment of the vulnerability of Australia's biodiversity to climate change*. A report to the Natural Resource Management Ministerial Council commissioned by the Australian Government. CSIRO Publishing, Canberra, Australia.
Steinfeld H., Gerber P., Wassenaar T., Castel V., Rosales M. and de Haan C. (2006). Livestock's long shadow. Food and Agriculture Organization of the United Nations, Rome.
Stoate, C., N.D. Boatman, R.J. Borralho, C. Rio Carvalho, G.R. de Snoo and P. Eden, (2001): Ecological impacts of arable intensification in Europe. *J. Environ. Manage.*, **63**, 337-365.
Tubiello, F.N., (2005): Climate variability and agriculture: perspectives on current and future challenges. *Impact of Climate Change, Variability and Weather Fluctuations on Crops and Their Produce Markets*, B. Knight, Ed., Impact Reports, Cambridge, UK, 45-63.
Turvey, C., (2001): Weather derivatives for specific event risks in agriculture. *Rev. Agr. Econ.*, **23**, 335-351.
US-EPA (1998). AP 42, Fifth Edition, Volume I, Chapter 14: Greenhouse Gas *Biogenic Sources*. US-EPA.
US-EPA (2006). Global Anthropogenic non-CO2 greenhouse gas emissions: 1990-2020. United States Environmental Protection Agency EPA 430-R-06- 005, Washington DC.
van Wuijckhuise, L., D. Dercksen, J. Muskens, J. de Bruyn, M. Scheepers and R. Vrouenraets, (2006): Bluetongue in the Netherlands; description of the first clinical cases and differential diagnosis; Common symptoms just a little different and in too many herds. *Tijdschr. Diergeneesk.*, **131**, 649-654.
Wang M.X. and Shangguan X.J. (1996). CH4 emission from various rice fields in PR China. *Theoretical and Applied Climatology* 55, 129-138.
Wassmann R., Lantin R.S., Neue H.U., Buendia L.V., Corton T.M. and Lu y. (2000). Characterization of methane emissions from rice fields in Asia. III. Mitigation options and future research needs. *Nutrient Cycling Agroecosystems* 58, 23-36.
West T.O. and Post W.M. (2002). Soil organic carbon sequestration rates by tillage and crop rotation. A global data analysis. *Soil Science Society of America Journal,* 66.
White, N., R.W. Sutherst, N. Hall and P. Whish-Wilson (2003): The vulnerability of theAustralian beef industry to

impacts of the cattle tick (*Boophilus microplus*) under climate change. *Climatic Change*, **61**, 157-190.
Williams A.G., Audsley E. and Sandars D.L. (2006). *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities*. Cranefield University and Defra Research Project ISO205, Bedford.
Xu H., Cai Z.C. and Tsuruta H. (2003). Soil moisture between rice-growing seasons affects methane emission, production, and oxidation. *Soil Science Society of America Journal* 67, 1147-1157.
Yagi K., Tsuruta H. and Minami K. (1997). Possible options for mitigating methane emission from rice cultivation. *Nutrient Cycling in Agroecosystems* 49, 213-220.
Yan X., Ohara T. and Akimoto H. (2003). Development of region-specific emission factors and estimation of methane emission from rice field in East, Southeast and South Asian countries. *Global Change Biology* 9, 237-254.
Xu H., Cai Z.C., Jia Z.J. and Tsuruta H. (2000). Effect of land management in winter crop season on CH4 emission during the following flooded and ricegrowing period. *Nutrient Cycling in Agroecosystems* 58, 327-332.