Australian Government
Department of Climate Change and Energy Efficiency

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Carbon Farming Initiative

Preliminary estimates of abatement

Discussion Paper

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Summary: DCCEE preliminary, indicative estimates of abatement in 2020 attributable to the Carbon Farming Initiative (CFI)

This document provides a Departmental preliminary indicative view of the abatement from the Carbon Farming Initiative in 2020. This work is separate from the Treasury modelling exercise regarding the Government's carbon pricing mechanism and its relationship to land sector abatement. The document is being released for the purposes of discussion with stakeholders regarding the Carbon Farming Initiative and estimates may change going forward.

Kyoto compliant activities

	Indicative estimate of abatement in 2020 (Mt CO_2-e)	
Activity	**Low**	**High**
Reforestation	1	2
Avoided deforestation and managed regrowth on deforested lands	1.5	6
Reduced Enteric Fermentation	<0.5	1.3
Nitrous oxide from Agricultural Soils	<0.1	<0.5
Manure Management	<0.1	1.1
Reduced Emissions from Rice Cultivation	0	<0.1
Reduced Emissions from Field Burning Residues	0	<0.1
Savanna fire management	<0.5	<1
Legacy waste management	<1	3.5
Subtotal	**<5**	**<15**

Notes:
1. Totals do not add precisely.
2. These numbers represent estimates of abatement in 2020 and not the number of CFI credits that would be issued in that year. Some sectors such as forestry may have crediting rules that mean the number of credits issued in a particular year will differ from the actual abatement in that year.

Non-Kyoto compliant activities		
	Indicative estimate of abatement in 2020 (Mt CO_2-e)	
Activity	**Low**	**High**
Forest management and revegetation under Article 3.4	~0	~0
Reforestation on non-Kyoto land	<0.5	<1
Revegetation of degraded rangeland under Article 3.4	<1	5
Increased soil carbon on cropping land	<0.5	<1
Use of biochar to enrich soil	Not able to be estimated	Not able to be estimated
Feral camel removals	Not able to be estimated	Not able to be estimated

Introduction

The Carbon Farming Initiative is a carbon offsets scheme being established by the Australian Government to provide new economic opportunities for farmers, forest growers and landholders and help the environment by reducing carbon pollution.

The Government consulted broadly on proposals for design of the scheme, outlined in a consultation paper released on 22 November 2010 by the Minister for Climate Change and Energy Efficiency, the Hon Greg Combet AM MP. Interested stakeholders were invited to provide feedback on the design proposals by making a submission to the Department of Climate Change and Energy Efficiency.

Legislation to underpin the Carbon Farming Initiative was introduced into Parliament on 24 March 2011.

Abatement estimates for the Carbon Farming Initiative

The indicative abatement estimates in this document have been prepared by DCCEE.

It is important to note that the indicative estimates in this document are of abatement that is likely to be achieved in 2020 given economic and other uptake constraints, including the incentive posed by a particular carbon price. For this reason the estimates are much lower than the various estimates of 'technical' potential that are in the public domain (e.g. Garnaut 2011 Update Paper #4 *Transforming Rural Land Use*; CSIRO 2009, *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*). As this analysis indicates and the Garnaut update noted only a small proportion of the 'technical' potential is expected to be achievable in the short term through the Carbon Farming Initiative (CFI).

The estimates are point estimates of abatement in 2020, not estimates of cumulative abatement over the period to 2020.

Many of the key factors that influence the level of abatement from the CFI are uncertain at this point. However, the Department has constructed indicative ranges to illustrate the likely magnitude of the abatement that could be achieved. In some cases, indicative estimates are unable to be made at this point in time, and in these cases, examples have been included to illustrate the relationship between actions and abatement.

The amount of abatement that will be generated by the CFI will depend on various factors including:

- final eligibility rules of the CFI;
- international accounting rules that apply to Australia;
- technical potential of the relevant sources;
- cost of generating the abatement credits;
- levels of participation by the relevant sectors;
- other relevant policies; and
- the price at which the CFI credits can be sold.

Additionality under the CFI

The CFI will credit abatement that is unlikely to occur in the absence of the scheme and therefore provides a genuine environmental benefit. This is known as 'additional' abatement. The Government will identify activities that go beyond common practice in a 'positive list' that will be included in the CFI regulations. The 'positive list' is

intended to provide a streamlined way of identifying activities that would not normally have occurred in the absence of the CFI. In assessing whether an activity is common practice, the impact of the scheme will be factored out. This means that activities that become common practice because of the scheme would not fail the additionality test.

The Government will consult with stakeholders to identify activities that are beyond common practice, and may undertake surveys as well as use other sources. This is to allow for the application of expert judgement as to what constitutes common practice in different environments and industry circumstances.

The list of the activities that go beyond common practice is under development. In order to make indicative estimates of the CFI abatement, assumptions have been made for individual activities and these are outlined below and in the relevant sections of Attachments A and B. The Minister must take the advice of the Domestic Offsets Integrity Committee before bringing forward regulations to include particular acitivites on the positive list.

Crediting arrangements

Some sectors have crediting rules that mean the number of credits issued in a particular year will differ from the actual abatement in that year.

For example some biosequestration activities, including soil carbon and reforestation, will result in significantly variable carbon stores. The amount of carbon in a reforestation project varies significantly depending on management actions such as thinning. Similarly, the amount of carbon in soil varies depending on rainfall. Credits for these projects will be issued up to the long-term average carbon storage. This provides a more realistic picture of the net permanent carbon stored by a project. Averaging will level out peaks and troughs in the number of credits that would be issued to proponents. Where the average amount is difficult to predict in advance, a rolling average could be used to re-calculate the crediting limit.

Abatement from some native forest protection projects will be credited over a number of years (likely to be around 20 years). That means that, for any given project, in each year, only one twentieth of the total abatement that will result from the project would actually be credited. Across the scheme, this means that in year one, only one twentieth of the total abatement from the activity would be credited. In the second year, that amount would be credited again, plus one twentieth of the abatement from new projects commencing in the second year, and so on for subsequent years. Assuming that new projects commence each year, the number of credits issued annually would be expected to rise until the twentieth year. In subsequent years they could be expected to be relatively stable.

Avoiding impacts on regional communities, water and biodiversity

To ensure that abatement projects do not have perverse or unintended impacts, offsets projects will need to comply with all state, Commonwealth and local government water, planning and environment requirements. Project proponents will also be required to take account of regional natural resource management plans. These provide a mechanism for local communities to have their say about the type and location of abatement projects.

Notwithstanding the coverage of the scheme, the Minister for Climate Change and Energy Efficiency may exclude projects that could have significant adverse impacts on water availability, food production, local communities, conservation of biodiversity or employment. These impacts may be in, or in the vicinity of, the project area, or any of the project areas, for that kind of project. The intention is that vicinity may be interpreted broadly, including water resource availability in associated catchments.

The Government has also committed to monitoring the impact of the scheme on the environment and on rural communities, and to taking steps to prevent perverse impacts if there is evidence that projects are likely to have a

material and adverse impact on the allocation of prime agricultural land, water availability or biodiversity. This provision will enable the Minister to address quickly any risks of perverse impacts.

Uncertainty surrounding eligibility rules

Some details of the CFI methodologies and eligibility rules are still under development. In order to make indicative estimates of the CFI abatement, assumptions in regard to these details have been made. The details of these assumptions are outlined below and in the relevant sections of Attachments A and B.

Uncertainty surrounding international rules

There is uncertainty about the international rules that Australia will be operating under (e.g. whether Australia will include additional land management activities, such as forest management, towards future mitigation commitments). For the first commitment period under the Kyoto Protocol, between 2008 and 2012, some of the land sector forestry activities, such as management of forests, croplands and grazing land, are voluntary (Article 3.4). This means that countries can decide if they will elect to take on additional commitments for the sector.

Because it can be difficult to separate emissions caused by human activity and those from natural events, the current rules assume that emissions from land that has any type of human activity on it are a result of human activity alone. Consequently if a country elects an activity, it must include all carbon movement from activities on the land. Australia has high risks of drought and bushfires, which can release large quantities of carbon dioxide (the burning of wood releases carbon, as does the decay of plants during times of drought). Therefore, Australia has chosen not to include emissions or removals from any Article 3.4 activities and hence has not elected to be subject to Article 3.4. This means that actions to increase soil carbon or reduce logging sit outside accounting for Australia's Kyoto target for the first commitment period.

"Technical" and "attainable" potential

In this paper, the level of abatement that is considered technically feasible by 2020 is referred to as the technical potential. "Attainable" abatement means the estimate of abatement after accounting for expected uptake of the technical potential.

These terms differ from those used in CSIRO's 2009 report *An analysis of greenhouse gas mitigation and carbon biosequestration opportunities from rural land use*.[1] That report examined the potential for emissions reductions from a range of activities relevant to this paper, over the period 2010 to 2050. It considered what it termed "potential", "attainable" and "base" abatement (or sequestration), which had the following meanings:

- Potential: the maximum biophysically possible.
- Attainable: attainable given concerted efforts to implement the technology/management changes taking into account uncertainty of estimates and the biophysical adjustment that may be needed to make a new system work.
- Base: what might be that attained given assumptions about political settings, institutional inertia, possible rates of adoption of technology and/or competing demands for land.

Uncertainty surrounding technical potential

Technical factors, such as the existence of appropriate technology and the geographic dispersion of emissions sources, will always limit the extent to which the national potential for abatement is actually achievable. The sectors have differing levels of uncertainty surrounding key technical potential and cost issues. The details of these assumptions are outlined in the relevant sections of this document.

[1] Eady, S., M. Grundy, M. Battaglia and B. Keating (2009).

A key uncertainty in preparing estimates for 2020 is the nature of technological development between now and then. Technological developments may result in new ways of reducing greenhouse gas emissions from the land sector, or may reduce the cost of existing emission reduction actions/practices, thereby increasing the extent and rate of adoption of those actions/practices.

Cost will be an important factor determining the extent of uptake of emissions reduction opportunities by land managers. These costs include the cost of technology, the opportunity costs that will be faced by land managers/owners considering changing their practices (e.g. the outlook for food and fibre prices through to 2020), and monitoring costs associated with participation. The voluntary nature of the CFI is also expected to reduce uptake.

Uncertainty surrounding uptake

Although the technical potential for abatement from the land sector is likely to be high (Garnaut 2011), there is high uncertainty surrounding the uptake of this potential through the CFI. Estimating 'attainable abatement' requires judgements to be made about how land managers/owners will change their behaviour (i.e. what they will do differently) in response to specific policy measures (in this case the CFI) and the rate at which they will change their behaviour over time in response to those specific measures. It also requires consideration of how the changed behaviour of direct beneficiaries of the measure will change the behaviour of others in the economy.

In many cases, methodologies needed to support abatement from Carbon Farming are still to be developed and approved. Key design features of the CFI (such as the requirement for permanence for biosequestration projects as well as the additionality test) will affect the cost of projects and hence uptake.

The CFI however offers an important opportunity for 'learning by doing' and road testing approaches. Greater abatement opportunities on the land are likely to be leveraged in the medium to longer term once the key players gain experience.

There is a range of developments that will be required to assist the technical potential of the land sector to be realised. These include methodology development, provision of information to land owners and managers and institutions that provide finance to the land sector, and building knowledge, understanding and confidence about the rewards and risks involved in the CFI.

Investments in these developments will require time to have an impact and influence uptake. Therefore we assume in all scenarios that the uptake of technical potential remains quite limited by 2020.

Uncertainty surrounding other policies

Existing and possible future (complementary) regulatory policies (e.g. restrictions on land clearing, or forest harvesting) have an impact on the behaviour of land managers/owners. For the purpose of this analysis it is assumed that the current regulatory environment remains in place until 2020.

Uncertainty surrounding CFI price

Kyoto-compliant CFI credits are assumed to be able to be sold to entities to offset their emissions voluntarilyor into the international market. The details of a domestic carbon pricing mechanism are currently under negotiation in the MPCCC and the rules of the international framework are still under negotiation in the UNFCCC. No decisions have been made regarding the initial fixed price or other important design elements.

The Australian Government is currently updating its projections of international carbon prices in 2020 for the Kyoto-compliant credits as part of modelling with regard to the proposed carbon price mechanism. For the purposes of this illustrative analysis it has been assumed that an international framework for the trading of carbon credits remains in place. We assume a nominal carbon price of A$33 per tonne of CO_2-e in 2020, based on a simplified price series of A$20 per tonne of CO_2-e in 2013, increasing at 5 per cent per annum in real dollars which

is a similar rate of increase to the previous Treasury models. The assumed carbon price series broadly reflects recent international carbon price movements such as the spot price of CER credits under the Clean Development Mechanism and has not taken into account any design decisions relating to the carbon price mechanism or further Treasury modelling of carbon prices.[2]

Holders of Kyoto-compliant CFI credits will have the option of selling them in international markets. Those who wish to sell them overseas will be able to either sell them as CFI credits or request the Australian Government to exchange them for AAUs and then sell the AAUs. In international markets, CFI credits will be a new and essentially unknown type of emission permit and for this reason may sell at a discount to CERs. Also, the international demand for AAUs is limited so that it is possible that there could be an oversupply of AAUs in international markets. If this was the case, they too would be expected to sell at a significant discount to CERs.

These considerations indicate that the price received for Kyoto-compliant CFI credits (or AAUs that they have been exchanged for) may be less than the price assumed in this analysis. Credits with a premium, such as biodiversity values, could also be sold for higher prices than other credits.

The CFI credits that are not Kyoto-compliant will be able to be sold only into voluntary markets. For the purposes of this analysis we assume the voluntary carbon price to be A$3 per tonne of CO_2-e in 2013, increasing to reach a nominal price of A$5 per tonne of CO_2-e in 2020. Further work is being done that assumes a $20 price rising to $33 per tonne in 2020. It is expected that the resultant change in abatement will be limited, as a number of the abatement processes face non-price barriers over the short to medium term.

High and Low Scenarios

To reflect the uncertainty underlying these abatement estimates, high and low estimates have been provided. The estimates are based on plausible 'optimistic' and 'conservative' scenarios, rather than a statistical analysis of the uncertainty around the level of future abatement.

Both high and low scenarios assume that uptake of the technical potential for abatement is relatively low by 2020. There is limited time by 2020 for any significant impact to result from the investments in capacity development that will be needed to encourage greater uptake.

The scenarios also assume continuation of international rules that apply to Australia in the first Commitment Period of the Kyoto Protocol.

The high scenarios (with the exception of that for reforestation) embody optimistic but plausible assumptions about the availability by 2020 of relevant technologies and the rate of uptake of technologically feasible opportunities. They incorporate assumptions of relatively low opportunity and monitoring costs.

In the low scenarios (with the exception of that for reforestation) more conservative assumptions are made about technology and uptake, with opportunity and monitoring costs assumed to be higher.

High and low scenarios for reforestation are based on a review of 2008 estimates by the former Australian Bureau of Agricultural and Resource Economics (ABARE).

[2] The reforestation estimates draws on estimates by the former ABARE to the Commonwealth Treasury as part of *Australia's Low Pollution Future* (2008) and uses the prices for the CPRS -5 scenario. These prices are broadly comparable to the series starting at A$20 in 2013 and rising to A$33 in 2020.

ATTACHMENT A: Assessments of abatement – Kyoto activities

Reforestation

It is estimated that reforestation as a result of the CFI will reduce Australia's emissions by between 1 Mt CO_2-e and 2 Mt CO_2-e in 2020.

Key assumptions

- It is assumed that CFI additionality criteria will exclude the following plantings from receiving CFI credits:
    - plantations of 'traditional species/rotation' established with the intention of harvesting for fibre (timber/chip) or biomass (energy) and selling these products.

Key sensitivities

- Area of land that would be reforested as a result of the CFI.
- Estimation and crediting rules that would apply under the CFI.

Background

- Previous estimates by the former ABARE to the Commonwealth Treasury as part of *Australia's Low Pollution Future* (2008) suggest that the average annual sequestration from environmental plantings over the period 2013 to 2022 under the CPRS -5 scenario would be 4.2 Mt CO_2 (Lawson et al., 2008).
    - It was estimated that annual establishment of carbon plantings would be around 66,800 ha.
    - The ABARE estimates were based on a set of specific assumptions, developed by the Australian Treasury in consultation with the former Department of Climate Change and the former Bureau of Rural Sciences. Some of the key assumptions related to land values, plantation costs and projected increases in commodity prices, land availability, and biomass growth and sequestration rates.
    - However, Lawson et al. noted that their projections could significantly overestimate the reforestation potential under the scenario in question because a number of specific assumptions underlying their estimates turned out not to be appropriate, but were necessary at that time given the paucity of appropriate data and/or policy positions on the relevant issues.
        : In particular, their estimates did not factor in possible restrictions on reforestation associated with biodiversity, conservation and the potential negative environmental impacts such as water interception.
        : Also, the estimates did not include any CFI-specific criteria such as 'additionality' which is likely to limit land use change from agriculture to carbon plantings.
    - To address some of these important issues, ABARES will update its 2008 estimates for reforestation potential using a refined and improved framework incorporating updated cost assumptions, biodiversity plantings including long rotation and Mallee, water prices to reflect

water interception by reforestation activities, and a more up-to-date map of Kyoto Protocol eligible land.

- Furthermore, the types of plantings that are expected to make up the majority of the CFI plantings are permanent (such as non-commercial, environmental plantings, or carbon specific plantings in lower rainfall regions), and would be growing at a relatively slow rate.
- With these constraints and updated costs data, it is expected that new ABARES estimates will be much smaller than those in the 2008 study.
- The high scenario assumes that sequestration is 50 per cent of that estimated in ABARE (2008). The low scenario assumes that sequestration is 25 per cent of that estimated in ABARE (2008).
  - This is broadly consistent with qualitative indications from discussions with stakeholders.

1.1 Avoided deforestation and managed regrowth on deforestation lands

This section has two parts: avoided deforestation, and managed regrowth on deforestation lands. It is estimated that abatement from these actions as a result of the CFI will reduce Australia's emissions by between 1.5 Mt CO_2-e and 6 Mt CO_2-e in 2020.

Deforestation is the direct human-induced conversion of forested land to non-forested land, as defined under Article 3.3 of the Kyoto Protocol. In Australia, deforested land is often subject to regrowth and periodic re-clearing. Emissions from clearing and removals from subsequent regrowth are included in Australia's deforestation emissions.

In general terms, avoided deforestation refers to projects that seek to preserve vegetation that is already there and that would not otherwise have been expected to occur. It does not include the cessation of logging in native forests, which falls under the non-Kyoto activity 'Forest management and revegetation under Article 3.4 (Native Forest Management)' (see Attachment B).

Managed regrowth refers to action by land holders to avoid re-clearing and instead promote regrowth on land that has previously been deforested. This could include fencing off or other actions to remove stock or preserve vegetation.

Key assumptions

- Where land clearing is prohibited by legislation it will not meet the additionality criteria under the CFI.
- Under the low scenario, it is assumed that 10,000 ha of deforestation (first time clearing) is avoided annually by 2020. Under the high scenario, 50,000 ha of deforestation is avoided annually by 2020.
- Each hectare of avoided deforestation reduces emissions by 100 t CO_2 per year.
- For managed regrowth, the high scenario assumes that approximately 9 per cent of cleared land returns to forest by 2020 and meets additionality criteria.
  - This is an area of 355,000 ha.

  - This is equivalent to an increase in regrowth of around 10,000 ha per year after 2012, plateauing at 50,000 hectares per year.

- Under the low scenario for managed regrowth, which assumes higher opportunity costs, around 4 per cent of cleared land returns to forest by 2020 and meets additionality criteria.
  - This is an area of 170,000 ha.
  - This is equivalent to an increase in regrowth of around 5,000 ha per year after 2012, plateauing at 20,000 hectares per year.
- It is estimated that for the first 10 years the regrowth would sequester around 2.5 t CO_2/ha/yr.

Background

- In the absence of the CFI, baseline deforestation emissions are projected to continue at approximately 49 Mt CO_2 per year for the foreseeable future.
  - However emissions from year to year are expected to fluctuate considerably with weather and market conditions. Rates of clearing generally depend on agricultural product markets (mainly beef) and climatic conditions. If agricultural prices remain strong, then the opportunity cost of avoided deforestation would be high. This could mean that agricultural product prices, rather than carbon price incentives, would be the key driver of deforestation decisions.
- There are very few examples of avoided deforestation projects. The only example in Australia is the *Minding the Carbon Store* (*MTCS*) project which implemented an avoided deforestation project under Greenhouse Friendly, albeit under particular conditions that are not necessarily readily applicable more generally.
  - The MTCS project was achieved by using the Queensland government's land clearing legislation as the basis for proving additionality. Under the new legislation, clearing of mature forest was banned as of 31 December 2006. However, those with existing permits could clear land until this time. *MTCS* purchased these clearing permits from farmers, thereby preventing them from clearing their land.
  - On average, each hectare of forest protected under *MTCS* resulted in emissions reductions of around 100 t CO_2.
  - The project permanently protected around 12,000 ha of mature vegetation. This resulted in a total emissions saving over the life of the project of over 1.2 Mt CO_2.
  - It is thought that the price paid for carbon under *MTCS* was less than one third of the carbon price that is assumed here in 2020.
- The MTCS experience is not readily translatable to the CFI. Also, in recent years other pieces of legislation have been implemented by various state governments, further regulating land clearing.
  - Where land clearing is prohibited by legislation it will not meet the additionality criteria under the CFI.

- The average area of land deforested annually over the five year period 2005-2009 was approximately 200,000 ha.
- Permanence requirements under the CFI are likely to dampen uptake, as they will significantly reduce the ability of land managers to respond to market and climatic conditions.
  - Reflecting the uncertainty around uptake of avoided deforestation projects, the high scenario assumes that 50,000 ha of clearing is avoided in 2020, resulting in 5 Mt CO_2 of avoided emissions. The low scenario assumes 10,000 ha of avoided clearing, equivalent to 1 Mt CO_2 of avoided emissions.
- For managed regrowth, there are currently approximately 5 M ha of land within Australia's Deforestation account.
  - Of this land approximately 4 M ha has remained clear of forest, with the remainder being subject to regrowth of vegetation.
  - Of this 4 M ha, a proportion may be available to be regrown to forest. Some would return to forest even in the absence of a carbon price incentive.
- Managed regrowth would be likely to involve removing land from agricultural production, and the opportunity cost of doing this would present an obstacle to uptake of projects.
- It is estimated that for the first 10 years, on average the regrowth would sequester around 2.5 t CO_2/ha/yr.
  - Projects are likely to have low growth rates and patchy regrowth, because much clearing has taken place in dryland areas, and it is expected that projects would be established largely by methods other than direct planting, such as fencing or removing grazing pressures.
  - Individual projects would have a high uncertainty of success.

Reduced Enteric Fermentation

It is estimated that the reduction in emissions from enteric fermentation in 2020 as a result of the CFI will be between 0.2 and 1.3 Mt CO_2-e.

Potential sources of emissions reductions by reducing enteric fermentation in cattle and sheep include herd management including breeding efficiency, feedlot finishing, feed supplements, pasture improvement, genetic improvement and vaccination. A further potential source is substitution of ruminants with animals that do not have enteric fermentation emissions, such as poultry and kangaroos. However strong export markets and consumer resistance to commodity substitution make it highly unlikely that such substitution would occur to any significant extent.

Feed supplementation has limited applicability due to the generally high cost of supplements such as oils and tannins which provide the greatest mitigation. In addition the abatement potential from use of feed supplements is limited because they are typically applied within the intensive livestock industries (feedlot and dairy cattle), which represent a small proportion of the total livestock herd. Vaccination and genetic improvements are considered less mature as abatement approaches and are unlikely to be implemented by 2020.

Key assumptions:

- Herd management, feed supplementation, feedlot finishing and pasture improvement are the most feasible sources of effective abatement by 2020.
- Feed supplementation is most effectively implemented in the intensive livestock industry (feedlot and dairy cattle), given that all other ruminant livestock graze on extensive improved and unimproved pastures over large tracts of land. Some improved pasture management is possible for grazing cattle and sheep in some parts of Australia.
- It is assumed that a significant proportion of dietary oil feed supplements would not be considered common practice within the industry, and therefore would satisfy the CFI additionality criteria.
- Given the existence of strong export markets and the need for Australian agriculture to re-stock following a decade of drought and floods, the productivity enhancements that result from feed improvement are likely to prove stronger incentives than abatement.
- Vaccines to reduce enteric fermentation would need to demonstrate efficacy, be tested to demonstrate that associated meat is safe for human consumption, gain acceptance so they do not affect export markets and be cheap enough for large-scale uptake. This combination is not expected to occur by 2020.
- The high scenario assumes that abatement in 2020 arises from feedlot finishing, feed supplementation, improved breeding efficiency and pasture improvement. Uptake of abatement opportunities across the dairy and grain-fed beef herds is assumed to be equivalent to 10 per cent abatement of emissions from these herds. Uptake of abatement opportunities such as improved breeding efficiency and pasture improvement across remaining herds is assumed to be much lower, reflecting the greater cost and physical challenges of increased management of grazing herds, particularly rangeland beef.
  - It is further assumed that all of this abatement is considered additional under the CFI.

Key sensitivities:

- No methodology exists yet for any of these abatement activities, and there is a high degree of uncertainty around the level of abatement that may result. The estimate of attainable abatement is likely to change as methodology development progresses and more information becomes available.
- The cost of feed supplements will strongly influence their uptake as a mitigation tool, particularly where there are no productivity benefits.
- Timing of development and market acceptance of vaccine.
- Relative cost of vaccination versus enteric emissions under a carbon price, once such vaccines become available.

Background

- In the absence of the CFI, baseline emissions from enteric fermentation are projected to be 61 Mt CO_2-e in 2020. Of this, sheep are expected to contribute just over 18 per cent, with cattle providing almost 82 per cent (68 per cent grazing beef, 10 per cent dairy, 3 per cent grain-fed beef).
  - Emissions from dairy and grain-fed beef are projected to make up around 8 Mt CO_2-e of total enteric fermentation emissions in 2020. The remainder are from grazing beef and sheep.
- Various forms of feed supplementation already occur, because this improves productivity. There are opportunities to use additional oil and tannin supplements that could provide additional methane mitigation. Cost of these products will determine their effective use as a mitigation tool.
- The extent of supplementation is not known, and the resulting abatement is not explicitly accounted for in the national inventory. It is likely that in many instances improved feed efficiency will translate into improved re-stocking or commodity production to respond to export and domestic markets, rather than abatement. A carbon price is expected to encourage further feed supplementation. The practice will, however, remain constrained by animal and commodity quality constraints, and its abatement potential may be reduced by alternative ways of exploiting productivity improvements.
- Many lipid containing feed materials reduce methane emissions, as well as increasing productivity when used as supplementary feeds. Additional supplementation could be obtained from other dietary oils such as cottonseed and canola oil. These reduce methane emissions from livestock but are not always associated with productivity benefits (for example, decreased milk fat percentage).
  - Consequently, it is assumed that a significant proportion of dietary oil feed supplements would not be considered common practice within the industry, and therefore would satisfy the CFI additionality criteria.
- Vaccines have been under development for many years but are not yet available. The timing of their development is uncertain (but certainly several years away), and their administration to grazing beef herds would be expensive.
- A high carbon price appears to be a necessary condition for widespread vaccine use, given their associated expense. However, a high carbon price alone would not be sufficient to achieve widespread

adoption of vaccines; there are additional hurdles, such as market acceptance (on public health grounds) that need to be overcome and which are independent of carbon price.

- Herd substitution is considered highly unlikely to occur on any significant scale. Export demand for Australian beef is projected to remain high, and within Australia there are very limited markets for kangaroo and significant regulatory hurdles to be overcome.
- In the high scenario it is assumed that:
  - The maximum attainable abatement from feedlot finishing and feed supplementation using current methods (above supplementation that already occurs) is 10 per cent of baseline emissions over the entire national herds for dairy and feedlot beef, equivalent to 0.8 Mt CO_2-e.
  - Uptake of abatement opportunities such as improved breeding efficiency and pasture improvement across remaining herds is one per cent, reflecting the greater cost and physical challenges of increased management of grazing herds, particularly rangeland beef. This is equivalent to 0.5 Mt CO_2-e.
  - All of this abatement satisfies CFI additionality criteria.
- In the low scenario, it is assumed that a lower level of abatement is attained, equivalent to 4 per cent of baseline emissions over the entire national herds for dairy and feedlot beef. It is assumed that half of this abatement satisfies CFI additionality criteria.

Agricultural Soils – nitrous oxide emissions

It is estimated that reductions in emissions from agricultural soils as a result of the CFI will be between 0.01Mt CO_2-e and 0.2 Mt CO_2-e in 2020.

Kyoto accounts include emissions of non-CO_2 gases from agricultural soils, but not of CO_2. Increased carbon stores in agricultural soils are covered in Attachment B, which deals with non-Kyoto compliant activities.

Potential sources of Kyoto-compliant emissions reductions from agricultural soils are the use of nitrification inhibitors and other changes to fertiliser management practices such as switching to different kinds of fertilisers.

Some fertiliser management practices are already fairly widespread (because they have productivity benefits), and hence are less likely to satisfy additionality criteria under the CFI. The main potential abatement sources that are likely to satisfy additionality criteria are the use of nitrification inhibitors, the use of new nitrogen fertiliser formulations (coated fertilisers), and some split application of fertiliser for improved nitrogen use by plants.

Key assumptions:

- In the low scenario, it is assumed that
  - abatement is from the use of nitrification inhibitors, coated fertilisers and some split application of fertiliser, and the technical abatement potential from these sources is 5 per cent of the

national technical potential abatement estimated by CSIRO from building carbon storage and mitigating N_2O emissions for cropped land[3]; and

  - Australian climatic conditions and price constraints result in their uptake being limited to 10 per cent of the estimated technical potential.

- In the high case, it is assumed that
  - abatement is from the use of nitrification inhibitors and other sources of fertiliser management, including split application and coated fertilisers;
  - the technical abatement potential from these sources is 30 per cent of the national technical potential abatement estimated by CSIRO from building carbon storage and mitigating N_2O emissions for cropped land; and
  - eligible uptake is 30 per cent of the technical potential.

Background

- Baseline emissions from agricultural soils are projected to be 16 Mt CO_2-e in 2020.
- Current fertilisers include animal waste and inorganic fertiliser.
- There are a number of commonly-occurring activities that may deliver abatement. These include switching to lower-emissions slow-release inorganic fertilisers and replacement of inorganic fertilisers with legumes.
  - Some of these activities are unlikely to satisfy the additionality criteria under the CFI.
- Switching to nitrification inhibitors is likely to be considered additional under the CFI as their use is not currently widespread. However, there is limited potential for this to occur.
  - The use of nitrification inhibitors will differ between regions because they are more effective in cooler than warmer climates.
  - They are currently more expensive than traditional fertilisers, although economies of scale over time may reduce this cost.
- The CSIRO released a report in August 2009, *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*.
  - This suggested a national potential of 25 Mt CO_2-e for building carbon storage and mitigating N_2O emissions for cropped land.
  - As some of this CSIRO estimate falls outside the Kyoto agricultural soils sector, the relevant national potential is less than this amount.

[3] CSIRO 2009, *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*.

  - CSIRO did not separate out the contribution of nitrification inhibitors in the total. It is thought that they would contribute only a minor proportion; combined with coated fertilisers and some eligible split application of fertiliser, the contribution was assumed to be 5 per cent for this exercise.
  - CSIRO estimated that in Queensland, which it estimated has 4 Mt CO_2-e of the total technical potential, 10 per cent (0.4 Mt CO_2-e) will be feasible by 2020.
  - Applying this ratio nationally as an initial estimate gives 2.5 Mt CO_2-e as the feasible technical potential in 2020, from the combination of building carbon storage and mitigating N_2O emissions for cropped land.

- Adoption of nitrification inhibitors will depend critically on their price. There appears to be volatility in the price relative to more traditional fertilisers, with estimates ranging from about 20 per cent more to double the price of traditional fertiliser. As noted above, economies of scale may reduce costs over time.
- A carbon price is expected to provide an incentive for the uptake of nitrification inhibitors. A sufficiently high price is required to overcome the cost barriers associated with nitrification inhibitors when compared with traditional fertilisers.
- The combination of methodology and research modelling is expected to be available for approval by the Domestic Offsets Integrity Committee (DOIC) in late 2012.

Manure Management

It is estimated that manure management as a result of the CFI will reduce emissions in 2020 by between 0.03 and 1.1 Mt CO_2-e per year.

Reducing emissions from manure management would involve capturing methane from manure management systems in piggeries and cattle feedlots, where large amounts of manure accumulate and undergo natural anaerobic decomposition.

Key assumptions

- In the low scenario, technical potential for abatement is 50 per cent of emissions from intensive livestock farming (1.9 Mt CO_2-e in 2020). In the high, it is 65 per cent (2.4 Mt CO_2-e in 2020).
- In the low scenario, eligible uptake of the technical potential abatement in emissions from pigs in 2020 is 5 per cent.
- In the high scenario, uptake of total abatement potential from all manure management in 2020 is 45 per cent.

Key sensitivities

- The cost of the infrastructure required to capture methane is significant, even for intensive livestock farming, and is likely to influence uptake.

Background

- In the absence of the CFI, baseline emissions from manure management are projected to be 3.7 Mt CO_2-e in 2020. Of this, swine are expected to contribute 36 per cent (1.3 Mt CO_2-e), poultry 19 per cent and cattle 44 per cent (30 per cent grain-fed beef, 14 per cent dairy beef and 1 per cent grazing beef).

- Australia's pork production capacity is concentrated, with about 100 large piggeries responsible for approximately two-thirds of production. Emissions are linked to production, meaning that these 100 piggeries are projected to emit about 0.9 Mt CO_2-e in 2020.

- As a consequence, the technical potential for abatement is thought to be relatively high, around 50 per cent of emissions.

- It is thought that despite the relatively high technical potential, uptake for some forms of intensive livestock farming would be limited and phased in over time at the carbon price assumed in 2020, due to large capital costs and long payback period. In this respect a carbon price is expected to provide an important signal in encouraging uptake, with higher carbon prices encouraging stronger uptake.

- There may be potential in piggeries to use captured methane to generate electricity on-site, which could encourage uptake. A pilot co-generation project is currently operational.

Reduced Emissions from Rice Cultivation

It is estimated that in 2020 there will be no emissions reductions from rice cultivation due to the CFI. Baseline emissions from rice cultivation in 2020 are projected to be very low (0.4 Mt CO_2-e). If a methodology is available, it is estimated that in 2020 the CFI would result in no more than 0.03 Mt CO_2-e of abatement.

Reducing emissions from rice cultivation could take the form of more frequent drainage of rice fields or switching from flooded to upland rice production, but in these cases any reduction in methane emissions may be negated by an increase in nitrous oxide emissions.

Key assumptions:

- Switching to upland rice cultivation is unlikely to be feasible, given the current location of Australia's rice production.

- More research is needed to demonstrate and quantify potential emissions reductions from changed management of wetland rice.

- In the low scenario no methodology is available before 2020. In the high scenario, a methodology is available in 2015.

- Technical abatement potential is less than 20 per cent of emissions.

- Uptake is approximately 30 per cent of the technical potential at the assumed carbon price in 2020.

Key sensitivities

- Demonstration of additionality.
- Research to demonstrate technical potential.

Background

- In the absence of the CFI, baseline emissions from rice cultivation are projected to be 0.4 Mt CO_2-e in 2020.
- More research is needed for Australia to quantify methane emissions savings under such measures.
- Technical potential to reduce emissions is thought to be relatively low, perhaps around 20 per cent. Thus the maximum potential abatement in 2020 is less than 0.09 Mt CO_2-e.
- Assuming that a methodology is available by 2015, and allowing for limited uptake, it is estimated that one third of this potential, or 0.03 Mt CO_2-e, would be delivered in 2020.
- Given the limited abatement potential in modifying rice cultivation practices, and the dominance of other drivers such as the need to cope with constrained water availability, a carbon price is expected to have limited influence on decisions that would affect abatement.

Reduced Emissions from Field Burning Residues

It is estimated that in 2020 there will be negligible emissions reductions due to the CFI from field burning residues.

Emissions from field burning involve the burning of stubble and crop residues (e.g. sugar cane).

Key assumptions

- Low demand resulting from low potential abatement.

Background

- In the absence of the CFI, baseline emissions from field burning of agricultural residues are projected to be 0.5 Mt CO_2-e in 2020.
- There is thought to be very low abatement potential as the difference of emissions saved from not burning stubble is very small.
- Given this, a carbon price is expected to have negligible impact on decisions to modify practices concerning field burning residues.

Savanna fire management

It is estimated that under the CFI the management of fires on savannas could reduce emissions from savanna burning in 2020 by between 0.3 and 0.6 Mt CO_2-e.

Tropical savannas are landscapes of dense grass and scattered trees that stretch across northern Australia from Broome to Townsville. They cover an area of around 1.9 million square kilometres (about one quarter of mainland Australia). Savannas occur on Indigenous-held lands, and on pastoral and conservation lands.

Management of wild fires on northern savannas has the potential to reduce non-CO_2 emissions from savanna burning by reducing the frequency and intensity of fires.

Key assumptions:

- The low scenario assumes that three projects to reduce fuel loads by burning go ahead on Indigenous-held lands by 2020; the high assumes that five proposed projects go ahead.
- Abatement from each project is assumed to be 0.1 Mt CO_2-e/year in the low scenario, and 0.12 Mt CO_2-e/year in the high scenario.

Key sensitivities:

- Technical potential for abatement is assumed to be 30 per cent of emissions. While the West Arnhem Land Fire Abatement (WALFA) project reportedly reached 40 per cent, it is considered unlikely that other projects could achieve this because of differences in baseline land management practices.

Background

- In the absence of the CFI, baseline emissions from savanna burning are projected to be 12 Mt CO_2-e in 2020.
- In 2008 emissions from savanna fires on Indigenous lands were estimated to be 7.6 Mt CO_2-e/year (Heckbert et al. 2008). This is around 65 per cent of total savanna fire emissions (approximately 12 Mt CO_2-e in 2010).
- Currently work on savanna fire management is occurring on Indigenous-held lands. A voluntary market offset project has been running for several years in western Arnhem Land, and work is progressing on development of a methodology broadly applicable to other fire management projects on Indigenous lands.
  - It is estimated that this project is delivering abatement of around 150 000 t CO_2-e a year. Original expectations were for abatement of around 100 000 t CO_2-e per year.
- The current expectation is that five projects could be operating by 2020. The five areas have already been chosen, and the Northern Australia Indigenous Land and Sea Management Alliance is working on capacity building. These projects have economic and social development goals, with support from both Commonwealth and state governments, but will need a carbon price to go ahead.

- The abatement level from the existing WALFA project is considered unlikely to be replicated in other projects. The lands in that project had previously been relatively poorly managed, therefore offering higher potential for emissions reductions below the baseline. The likely range is thought to be from 100 000 t CO_2-e a year to around 120 000 t CO_2-e a year.

- The cost of abatement under the pilot project is around $12-13 per tonne of CO_2-e abated. The level of abatement is expected to be quite insensitive to price, as non-monetary factors, particularly capacity to establish and manage projects and the short-term availability of skilled staff, constrain the expansion of projects.

- On non-Indigenous land, fire management projects aimed at generating offsets are considered unlikely. Fire management on pastoral properties aims to reduce 'woody weeds' that interfere with grazing, rather than reduce the intensity of fires. If any project did go ahead it may be more capital-intensive than projects on Indigenous lands, which seek to provide employment and other benefits. One suggestion is the use of unmanned drone aircraft, which would have high set-up costs but reportedly low marginal cost of abatement. This is considered highly speculative and is not included in the estimates.

Legacy waste management

It is estimated that management of legacy waste emissions under the CFI could reduce emissions in 2020 by between 0.7 Mt CO_2-e and 3.5 Mt CO_2-e.

The CFI legislation states that CFI offsets can be generated from legacy waste and non-legacy waste deposited until a date to be nominated by the Minister. The date will reference the commencement of a carbon price.

Under the CFI, it is estimated that emission reductions in 2020 will come from the following sources:

- up to 1.8 Mt CO_2-e from new projects in response to the CFI price;

- up to 0.7 Mt CO_2-e from projects currently undertaken in the Greenhouse Friendly program (DCCEE 2011, *Australia's emissions projections 2010*); and

- up to 1.0 Mt CO_2-e from projects in the NSW Greenhouse Gas Reduction Scheme (NSW GGAS).

Key assumptions:

- Methane destruction or avoidance (flaring, electricity generation and waste diversion) that is not performed to meet either planning approval requirements, licence conditions or other regulatory requirements would be eligible to create CFI credits.

  – The bulk of baseline capture is assumed to be driven by planning requirements, and therefore not eligible for CFI credits. Should this assumption be incorrect, the number of credits generated could be higher.

- Abatement of emissions from legacy waste is eligible under the CFI.

– The definition of legacy waste is assumed to be waste that has been or would normally be deposited in landfill prior to the commencement of carbon price on 1 July 2012.

– It is assumed that NSW GGAS closes at the start of a carbon price and that not all GGAS projects satisfy CFI additionality criteria.

– Greenhouse Friendly landfill gas projects are eligible for CFI credits.

Background

- In the absence of the CFI, baseline emissions from legacy waste are estimated to be around 7 Mt CO_2-e in 2020. This is around 60 per cent of projected total landfill emissions in 2020 of 11.8 Mt CO_2-e (*Australia's emissions projections 2010*).

- For the high scenario it was estimated that up to 1.8 Mt CO_2-e of new abatement could potentially occur in 2020, driven by the assumed carbon price. In the low scenario it was assumed that no new projects are driven by the CFI.

  – According to the report *Climate Change and the Resource Recovery and Waste Sectors: Report to Department of the Environment, Water, Heritage and the Arts*, (MMA 2010), at the assumed carbon price in 2020 approximately 6 Mt CO_2-e per annum of additional abatement could be economical at landfills.

  – However, only a small proportion of this economical abatement is from legacy waste or uncovered sites.

  – Legacy waste emissions are projected to be approximately 58 per cent of total landfill emissions in 2020. Assuming that abatement rates are similar at all sites, up to 58 per cent of the economical abatement (3.5 Mt CO_2-e) could occur on legacy waste emissions.

    : However, the MMA report notes that a higher carbon price is required to drive abatement from legacy waste. It is generally more expensive to install infrastructure such as piping at old landfill facilities if they are no longer operational and filling. If these projects have a short life, there would be less time to recoup the installation cost.

  – The actual cost of abating legacy waste emissions is site specific. To demonstrate this uncertainty, for the low scenario it was assumed that no new abatement projects occur, while in the high scenario it was assumed that 50 per cent of the implied abatement potential from economic analysis of projects at covered sites is expected to occur (1.8 Mt CO_2-e).

- It was assumed that all Greenhouse Friendly landfill gas projects would be eligible under the CFI in both high and low scenarios. In 2020, abatement from these projects was estimated to be 0.7 Mt CO_2-e (*Australia's emissions projections 2010*, DCCEE).

- It was estimated that under the CFI up to 1.0 Mt CO_2-e of abatement would occur in 2020 from projects currently undertaken in the NSW Greenhouse Gas Reduction Scheme (NSW GGAS).

- In 2009 3.3 Mt CO_2-e of NGACs were generated by landfill gas projects under the NSW GGAS (Compliance and Operation of the NSW Greenhouse Gas Reduction Scheme during 2009, IPART). The bulk of this abatement is expected to be from methane destruction.

- It was assumed that abatement from GGAS projects decreases by 40 per cent from 3.3 Mt CO_2-e in 2009 to 2.0 Mt CO_2-e in 2020. This is in line with the projected decrease in legacy waste emissions over that period.

- GGAS did not require projects to demonstrate additionality in order to be eligible, and some landfill projects are required by regulations. There is uncertainty around how much of GGAS landfill abatement would be beyond common practice and regulatory thresholds, and could therefore be treated as additional under the CFI. The Department is working with these participants to better understand these issues and develop the positive list of activities.

ATTACHMENT B: Assessments of abatement – non-Kyoto activities

The CFI allows for methodologies to credit non-Kyoto abatement – abatement that does not reduce Australia's emissions under the Kyoto Protocol rules.

This paper quantifies, as far as possible, potential non-Kyoto CFI abatement. The scope is limited to activities where stakeholders have indicated that either a CFI methodology is likely to be proposed or there is community interest.

Forest management and revegetation under Article 3.4 (Native Forest Management)

Forest Management refers to activities associated with managing forests that existed in 1990. This activity does not include the impacts on removals and emissions of forests established on new lands since 1990 (which are covered under Reforestation). The Department is aware of the potential for some projects to be undertaken in this category and is working with stakeholders to consider the likely abatement outcomes that might be obtained, although it believes that the overall amount of abatement will be relatively small.

Reforestation on non-Kyoto land

It is estimated that reforestation on non-Kyoto lands could reduce emissions in 2020 by between 0.2 Mt CO_2-e and 0.5 Mt CO_2-e.

Background

Managed regrowth on non-Kyoto lands involves the active management of woody regrowth on land that is not counted towards Australia's Kyoto target because it was not forested in 1990 and because the regrowth does not involve direct seeding or planting (in which case it would be counted as reforestation).

- Regrowth can be induced through activities, including:
  - fencing of lands to prevent grazing;
  - changes in fire management regimes to promote forest growth.
- Compared to managed regrowth on Kyoto Protocol (KP) land:
  - The available land area for managed regrowth on non-KP lands is considerably larger than managed regrowth on KP lands. However, the exact area that is available is difficult to assess given Australia's large land mass (769 M ha) with only 108 M ha of forest and only a small proportion of this currently clear land receives sufficient rainfall to support the growth of forests.
  - Managed regrowth on non-KP lands is likely to have patchy growth leading to low overall annual growth rates (2.5 t CO_2/ha/yr).

- For the purposes of this projection it was assumed that only 50 per cent of the area would be included under managed regrowth on non-KP lands. This reflects barriers to undertaking projects in remote areas including complex land tenure arrangements.

- The estimate under the low scenario is therefore 0.2 Mt CO_2 in 2020, and 0.45 Mt CO_2 in the high scenario.

Revegetation under Article 3.4

There is an extremely high level of uncertainty around the potential for emissions reductions from revegetation, for reasons outlined below. It is estimated that emissions reductions in 2020 from the CFI may be between 0.5 Mt CO_2-e and 5 Mt CO_2-e.

Revegetation refers to the husbandry of plants that do not fall within the Kyoto definition of forest, either by replanting or human-induced regrowth. It includes shrubby vegetation and grasses, for example shrubby rangelands growth on marginal country and grasslands restoration projects. Revegetation is also covered by Article 3.4 of the Kyoto Protocol.

Key assumptions:

- Estimates regarding the areas of land undergoing these forms of revegetation, or eligible for undergoing these forms of revegetation, are hugely variable and uncertain, as are the associated estimates for the relevant degrees of rehabilitation and consequent carbon sequestration.

- Consultation with the CSIRO indicates that this is an ongoing research topic. As CSIRO (2009) states

  > "Clearly there is a massive shortfall of data needed to back up and provide the information base on which to design a workable C-trading scheme involving alternative management strategies for the Australian rangelands. Thus, it is impossible to design a trading scheme involving increasing soil or ecosystem C stocks in the Australian rangelands within the next few years that will effectively and quantitatively ensure decreased net emission of greenhouse gases to the atmosphere."

- CSIRO (2009) estimates the sequestration potential over 40 years for deteriorated grazing land across Australia to be 4,000 Mt CO_2-e, equivalent to 100 Mt CO_2-e/yr on average. However the study notes that there is extremely high uncertainty around this estimate. The possible range was estimated to be from 10 Mt CO_2-e/yr to 1000 Mt CO_2-e/yr.

- The paper estimates the technical potential for abatement (termed 'attainable' in that paper) for Queensland to be around half of the total potential. Applying this ratio across Australia implies a technical potential sequestration rate of 51 Mt CO_2-e/yr. The associated uncertainty range would be from 5 Mt CO_2-e/yr to 514 Mt CO_2-e/yr.

- The high scenario is based on assumed rate of uptake of CSIRO's 'best' estimate, rather than the upper end of its uncertainty range. The technical potential indicated by the upper value is considered unlikely to prove technically feasible by 2020.In the low scenario, the low end of the uncertainty range is used.

- The CSIRO study does not consider likely uptake rates, which are expected to be limited given a low carbon price. In the high and low scenarios, it is assumed that 10 per cent of the technical potential is

taken up by 2020. This results in approximately 5 Mt CO_2-e of abatement in the high scenario, and 0.5 Mt CO_2-e in the low scenario.

Increased soil carbon on cropping land

Assuming gradual uptake, it is estimated that increased soil carbon, or reduced losses, on cropping land could deliver abatement of between 0.3 and 0.5 Mt CO_2-e per year by 2020.

Key assumptions:

- The CSIRO national potential for building soil carbon, which also includes the mitigation of N_2O emissions for cropped land, is estimated to be 25 Mt CO_2-e per year.
- We assume that Australia's technical potential is 10 per cent of the CSIRO[4] national potential, given the assumptions made by CSIRO about the relationships between potential and attainable estimates of soil carbon sequestration and nitrous oxide reduction for Queensland soils. On this basis, Australia's technical abatement would be 2.5 Mt CO_2-e per year by 2020.
- In the high scenario, uptake by 2020 is assumed to be 20 per cent of the technical potential, leading to abatement of 0.5 Mt CO_2-e. In the low scenario uptake by 2020 is assumed to be 10 per cent of the technical potential, leading to abatement of 0.25 Mt CO_2-e.
- The implementation of conservation farm management practices is continued over time to ensure the maintenance of the rate of sequestration and, once the new higher soil carbon stock equilibrium is reached, to ensure permanence of that higher soil carbon stock.

Background:

- Most current practices for sampling and analysis may be relatively expensive, but new and emerging techniques may reduce this cost over time.
- The technical potential for the soil carbon sequestration rate is likely to be less than the value given in the CSIRO report[4] because this value is a combination of both soil carbon sequestration and reduction in soil nitrous oxide emissions.
- The CSIRO estimated a national potential for building soil carbon and mitigation of N_2O emissions for cropped land of 25 Mt CO_2-e per year.
- The potential soil carbon sequestration rate assumes that the sequestered carbon will remain permanently in the soil. A change in farming practice, for example from pasture to cropping or no-tillage to tillage may lead to a loss of the sequestered carbon. In the CSIRO Report this reduces the overall abatement potential. Adherence to CFI methodologies would minimise the risk of losing sequestered soil carbon and allow abatement to continue to occur for as long as sequestration continues to raise stocks of carbon in the soil.
    - In other CSIRO work (Sanderman et al., 2010) the annual per hectare rates of sequestration were identified as being highly variable, with a range from 0 to 0.6 tC/ha/yr depending upon climate, soil management and vegetation.[4] The land area associated with any soil carbon sequestration rate will

[4] Sanderman, J., R. Farquharson and J. Baldock , *Soil Carbon Sequestration Potential: A review for Australian Agriculture* (July 2010).

define the national potential. Care must be taken in the appropriate allocation of land use and assessment of climate when estimating sequestration rates.

Use of biochar to enrich soil

Insufficient information is currently available to estimate the non-Kyoto CFI abatement associated with use of biochar to enrich soils.

Biochar is a stable form of charcoal produced from heating natural organic materials in a high-temperature, low-oxygen process known as pyrolysis. It is chemically and biologically more stable than the original carbon form from which it is derived, making it more difficult to break down. This means that in some cases it can remain stable in soil for hundreds or thousands of years.[5]

It has been widely suggested that biochar could be used to enrich soils, simultaneously improving soil productivity and storing carbon. However a criticism of this process for soil enrichment is that it is dependent on rainfall and climate and in some instances operates over a centuries-scale timescale before productivity is improved.

The Department of Agriculture, Forestry and Fisheries is investing in biochar research, in collaboration with CSIRO. The technology is still being explored and is experimental.

Feral camel removals

At present there is limited information about the potential for abatement from feral camel removals under the CFI.

The level of abatement will depend on supply factors such as the costs of camel removal (which is highly weather-dependent), and on demand, which may be affected by the association with hunting and killing wild animals.

Key Assumptions

- Assuming that emissions credited from removing one camel would be equivalent to the emissions over its average remaining lifespan, the estimated emissions reduction from removing one camel would be around 15.3 t CO_2-e.[6]

Background:

- Recent camel culls have involved between 20,000 and 30,000 camels annually. This would reduce emissions by between 0.3 and 0.5 Mt CO_2-e (between 14,400 and 29,100 tonnes annually over the average 15 year reduction in lifespan).
- Annual emissions per camel are 0.97 tonnes CO_2-e/year (UNFCCC default factor).
- The life span of a feral camel is approximately 30 years. (In captivity camels live 40 years, a shorter life span is assumed for wild camels.)
- As the average age of a culled camel is reported to be 14.23 years, the average reduction in lifespan from

[5] http://www.csiro.au/files/files/pnzp.pdf
[6] Data and advice from sources including Rural Solutions SA (South Australian Government), SEWPAC (the Caring for Our Country initiative) and the Emission Reduction Company have been used in this analysis.

culling is 15.77 years.

The emissions avoided per camel removed would be:

(Years by which camel life span reduced) * (annual emissions)

= 15.77 * 0.97

= 15.30 tonnes CO_2-e/camel

A methodology for camel culling has been developed.