Opportunities for Australian horticulture in the Carbon Farming Initiative

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Final Report
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This report provides a detailed review of the Carbon Farming Initiative, identifies the range of possible activities, outlines the latest methodologies suggested for approval, and reviews the opportunities for horticultural enterprises.

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Contents

1 Summary

The Carbon Farming Initiative (CFI) is a voluntary agricultural carbon offset scheme that complements the Government's *Clean Energy Future* plan. Under the CFI, farmers and landowners can earn carbon credits through projects that reduce emissions of greenhouse gases, or that sequester carbon in the environment.

The CFI scheme provides a single framework that covers offset projects and markets, simplifying the process for farmers and landowners. It is a voluntary scheme implemented to provide an incentive for agricultural businesses to reduce emissions or increase carbon sinks by offering economic rewards.

CFI projects must be based on approved methodologies that provide detailed descriptions of eligible activities, and rules for implementation and monitoring of the abatement activities.

The potential for the horticultural sector to participate in the CFI is considered to be considerably lower than that for other agricultural businesses. Horticulture is characterised by intensive production of high value products on small land areas compared to other agricultural businesses. The most promising type of CFI project seems to be mitigation of nitrous oxide emissions from improved fertiliser management. However, projects such as reforestation, revegetation and carbon soil sequestration may also provide opportunities for some growers. Environmental plantings could be used as windbreaks or visual screens and thereby provide additional benefits to the farm.

Uncertainties about the carbon market, the level of demand for credits, and realistic abatement and sequestration potentials make it difficult to estimate the actual economic potential for horticulture at this time. However, all of the available information suggests that the income potential for horticultural producers will be limited.

2 Introduction

The *Carbon Farming Initiative* (CFI) provides a mechanism that allows landowners to generate carbon credits by conducting projects that reduce emissions or sequester carbon in the environment.

This project has assessed opportunities for horticultural enterprises to generate credits in the CFI. Topics included:

- A review of the CFI scheme and procedures for CFI projects.
- An analysis of opportunities for horticultural enterprises in the CFI, including the identification of possible activities and methodologies
- An assessment of the research and development required to develop the methodologies that will underpin horticulture-based CFI projects
- An estimate of the extent of emissions abatement and carbon sequestration potential for a number of key commodity groups
- An estimate of realistic income potential from activities in the CFI
- The implications of the CFI for land use changes, horticultural productivity and food security.

This final report summarises the CFI legislation and regulations, reviews the opportunities for horticultural enterprises in the CFI, identifies the range of possible activities, and outlines the latest methodologies suggested for approval.

3 The Carbon Farming Initiative

The CFI is a voluntary carbon offset scheme that complements the Government's *Clean Energy Future* plan. The implementation of the *Clean Energy Future* plan, which will establish a price on greenhouse gas (GHG) emissions using an *emissions trading scheme* (ETS), will lead to an emergence of a new sector in the economy focusing on carbon. Agricultural enterprises will not be required to participate in the ETS. However, agriculture and forestry are accountable for about 18 per cent of Australia's GHG emissions and the Australian Government believes that it will be difficult to reach national GHG abatement targets without a contribution from these industries (DAFF, 2012a).

The Government has designed the CFI scheme to ensure that the large potential for abatement and carbon sinks in the land sector are exploited even though it is not regulated directly by the *Clean Energy Future* plan. The CFI is intended to deliver the most cost-effective abatement and sequestration measures within rural Australia.

3.1 The basic structure

Under the CFI scheme, farmers and landowners can earn carbon credits through projects that reduce GHG emissions, commonly referred to as carbon emissions, or sequester carbon in the environment.

The CFI scheme provides a single framework that covers offset projects and markets, simplifying the process for farmers and landowners. It is a voluntary scheme implemented to provide an incentive for agricultural businesses to reduce emissions or increase carbon sinks by offering economic rewards.

Three GHGs are relevant for agriculture:

- Carbon dioxide, CO_2, is mainly released from microbial decay or burning of plant litter
- Methane, CH_4, is mainly released from livestock and rice cultivation
- Nitrous oxide, N_2O, emissions result from fertiliser use, particularly where the amount of nitrogen in the soil exceeds plant requirements (Smith et al., 2007).

Each GHG has a different *global warming potential* (GWP) which describes its ability to warm the atmosphere depending on the amount of infrared radiation the gas can absorb and how long the gas will remain in the atmosphere. The effect is expressed in units called carbon dioxide equivalents (CO_2-e) using CO_2 as the standard for reference comparing other GHGs to the effect of CO_2 as seen in the table below.

Table 1: Global warming potentials (GWP) of the three major greenhouse gases (Department of Climate Change, 2008).

Greenhouse gas	GWP (CO_2-e)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310

Projects for the CFI Scheme must be approved by the Carbon Credits Administrator (CCA). The CCA is the body that will assess applications, review project reports, issue certificates of entitlements to credits and ensure compliance of the relevant acts (The Carbon Market Institute, 2011):

- The Carbon Credits (Carbon Farming Initiative) Act 2011
- The Carbon Credits (Consequential Amendments) Act 2011
- The Australian National Registry of Emissions Units Act 2011.

For projects to be approved, a number of key requirements have to be fulfilled (DCCEE, 2010):

- The abatement or sequestration must be additional to “business as usual”; i.e. the reduction or storage of carbon would not have occurred without the project
- For sequestration projects, a permanency requirement applies to ensure that stored carbon is not re-released into the atmosphere for at least 100 years
- The action taken should not cause leakage, where reduction in emissions within the boundaries of the project will lead to increased emissions elsewhere

- To quantify and verify the abatement and sequestration, it will have to be measurable through technical processes and monitoring systems
- The assumptions of abatement and storage quantities will have to be conservative to avoid over-estimation
- The project method must be supported by peer-reviewed scientific evidence.

For all projects, it is essential that they are consistent with relevant natural resource management plans, local and state planning laws, and environmental regulations.

Applications for sequestration and emissions avoidance projects related to size of land need to include geospatial mapping. Mapping is required to provide the CCA with the necessary information to ensure that land areas are not covered twice, determine whether the project complies with international standards, clarifies whether there is native title, and determine who has the right to undertake the project.

3.2 Carbon credits

Each tonne of carbon dioxide equivalent reduced or stored as a result of a CFI project is equivalent to one *Australian carbon credit unit* (ACCU).

There are two categories of ACCU depending on whether they meet Australia's obligations under the Kyoto Protocol (see section 2.3) or national standards. Actions that will meet the requirements set up for the Kyoto Protocol include reforestation, fire management and reductions in pollution from livestock and fertiliser. These activities will acquire Compliance ACCUs which will be eligible for both the international and national compliance market as well as for volunteer markets. Other activities that do not comply with the Kyoto Protocol will be supported by the ongoing Carbon Farming Initiative non-Kyoto Carbon Fund and will acquire voluntary ACCUs which are eligible only for the volunteer market (and are likely to have substantially lower value).

For sequestration projects with a permanency requirement, it is possible to withdraw a project after it has commenced; however, all acquired ACCUs must then be relinquished. If carbon stores are lost or destroyed for any reason and not re-established, ACCUs should also be relinquished. If these requests are not met, CCA can apply a carbon maintenance obligation. A carbon maintenance obligation will restrict the future uses of the land to preserve the remaining vegetation and prevent further losses of sequestered carbon. The carbon maintenance obligation will apply for 100 years or until any outstanding relinquishment or penalties have been paid. The carbon maintenance obligations can also be applied if projects are not properly transferred, or if the project proponent dies or becomes insolvent (DCCEE, 2012a).

Carbon storage projects will be subject to the risk of natural disasters, diseases or pest attacks. To avoid re-releases and ensure environmental integrity, the Government will withhold five per cent of the credits from sequestration projects. This *risk of reversal buffer* is established for the scheme to avoid liability for carbon losses while the carbon sinks are being re-established after natural disturbances.

3.3 International standards

The Kyoto Protocol forms the foundation for an international carbon market along with national carbon price legislations, such as Australia's *Clean Energy Future* plan and similar schemes in the European Union, North American states and New Zealand. The original

commitment period for the Kyoto Protocol was 2008-2012; however, international negotiations in December 2011 prolonged this period until 2017.

The Kyoto Protocol requires Australia to limit its emissions of GHGs to 108 per cent compared to 1990 levels. The protocol enforces monitoring of emissions and includes three mechanisms for mitigation; Emissions Trading, the Clean Development Mechanism and Joint Implementation. Each country with obligations under the Kyoto Protocol has been assigned a number of allowed emissions; Assigned Amounts Units (AAU). Similar to Australia's ACCUs, one AAU allows the emission of one tonne of GHGs. If a country does not have sufficient AAU, these can be purchased or earned via the three mechanisms under the protocol. It allows countries to purchase credits from schemes such as the CFI (UNFCCC, 2012).

3.4 The offsets market

ACCUs generated under the CFI can be sold to offset the cost of the action taken to generate the credits and provide extra income. Buyers of ACCUs will typically be businesses that are required to participate in the ETS under the *Clean Energy Future* plan or similar schemes in other countries. With restrictions on emissions, businesses will consider and investigate whether abatement activities to cut emissions or purchasing credits externally will impose the lowest costs. Some credits will be bought voluntarily by businesses who want to lower their carbon footprint and gain an environmentally friendly image. Environmentally concerned businesses, organisations and individuals can also buy and cancel credits voluntarily to ensure lower carbon emissions.

Compliance ACCUs are internationally eligible under the Kyoto Protocol legislation. They can be sold internationally as CFI credits or exchanged by the Australian Government to the more international recognised AAUs. The price that can be obtained for these credits will be influenced by the demand on the international market. Although many countries and North American states do have carbon markets, not all of them will consider all types of Australian credits eligible for their market. For example, the European market does not recognise credits obtained from reforestation even though these are eligible under the Kyoto Protocol (European Commission, 2010). On the other hand, credits acquired with a special consideration (e.g. complementary biodiversity benefits) could obtain a higher price than other credits. These restrictions and considerations will further make it difficult to estimate demand and expected price which are sensitive to many parameters such as international negotiations and action, national initiatives and technical development.

Voluntary ACCUs will be generated from CFI eligible activities that do not comply with the international Kyoto standards. These credits will only be accepted on the voluntary market, both nationally and internationally.

The Government's Carbon Farming Initiative non-Kyoto Carbon Fund will buy voluntary credits to increase the incentive to undertake projects that fall outside the international requirements and do not count towards Australia's international obligations. $250 million will be administrated by the fund over six years starting from 2012-2013 (DCCEE, 2012b). The fund will help increase the price of voluntary credits but they are still expected to be considerable lower in value than compliance credits. The Department of Climate Change and Energy Efficiency's (DCCEE) report from 2011 sets the price for voluntary credits to $3 by 2013 (DCCEE, 2012c).

In Australia, the price for an ACCU will be set at $23 during an initial fixed price period (2012-2015) in the ETS, increasing at 2.5 per cent per year. From 2015, the price that can

be acquired for ACCUs will be determined by the markets. High levels of uncertainty related to the number of offset projects, the related costs and the price in general for abatement activities make it difficult to predict the demand and therefore price of future credits at this time.

3.5 Projects

To be eligible for a CFI project, an applicant must be a Recognised Offset Entity.

In the first instance, a Fit and Proper test will be conducted to examine whether the person is who he claims to be, if there has been any convictions of dishonest conduct that could be relevant to CFI projects or any case of insolvency. Applicants will therefore have to provide information about themselves or about the organisation and key personnel involved in the project. A police check will also be conducted. These measures are necessary to ensure the integrity of the scheme.

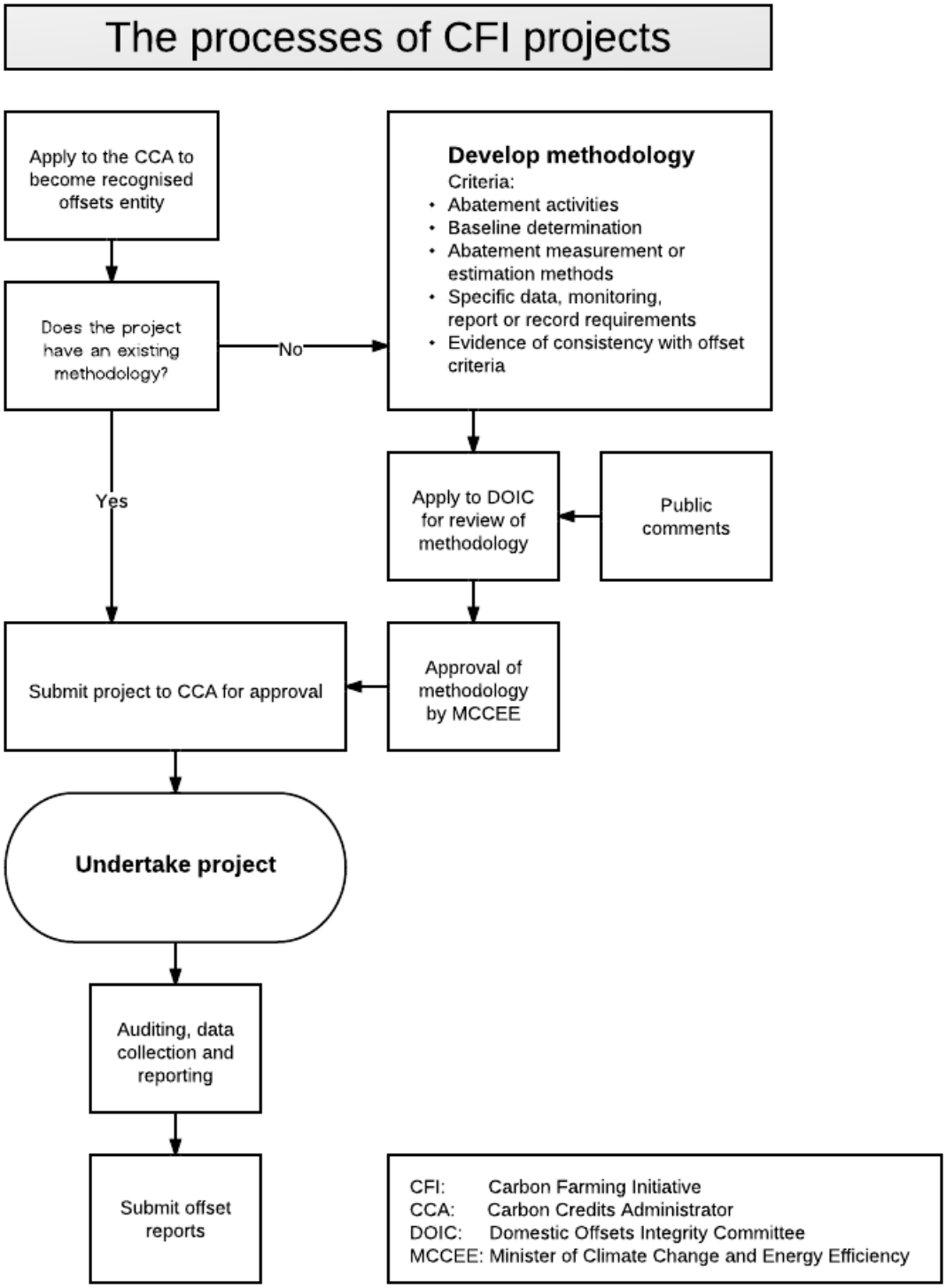
The methodology or project proposal can be sent to CCA before the applicant is a Recognised Offset Entity to shorten the approval process. However, only when the applicant is a Recognised Offset Entity will he/she be able to start the CFI project.

The scope of the CFI scheme includes activities in the following categories:

- Agricultural emissions avoidance
- Landfill legacy emissions avoidance
- Introduced animal emissions avoidance
- Sequestration offsets.

The steps required for undertaking a CFI project are presented in figure 1.

Figure 1: The processes of CFI projects.



3.6 Methodologies

The methodology for a CFI project includes a detailed description of eligible activities, rules for implementation and monitoring of the abatement activities. The methodology also defines the baseline (i.e. business as usual), with an estimate of emissions or storage activity without implementation of the project. Methodologies can be developed by private persons, government, research institutions, universities or non-governmental organisations. However, the cost and complexity of methodology development are likely to exclude individuals from the process.

The Domestic Offsets Integrity Committee (DOIC) will assess proposed methodologies and advise the Minister for Climate Change and Energy Efficiency who will make the decision on whether to approve the methodology.

At this time, there are only four approved methodologies that can be employed in CFI projects (DCCEE, 2012d). They are:

- Environmental plantings
- Destruction of methane generated from manure in piggeries
- Capture and combustion of landfill gas
- Savanna burning.

In addition, a number of methodologies are currently under consideration (DCCEE, 2012e):

- Avoided emissions from diverting waste from landfill through a composting alternative waste treatment technology
- Destruction of methane from piggeries using engineered biodigesters
- Diverting waste to an alternative waste treatment facility
- Avoided emissions from diverting waste from landfill for process engineered fuel manufacture
- Native forest protection projects
- Management of large feral herbivores (camels) in the Australian rangelands
- Reforestation and afforestation
- Measurement-based methodology for Farm Forestry Projects.

The two last proposed methodologies will be further addressed in sections 7.1 and 7.2.

3.7 Positive and negative lists

When a project has an approved methodology it can be sent to Carbon Credits Administrator (CCA) for approval.

For a project to be approved, it has to lie within the scope of the CFI scheme, be covered by an approved methodology and be on the positive list.

The positive list identifies activities that are additional; i.e. the activity is not required by law or already widely adopted as common practice in the industry or environment. The details for requirements for a project to be included on the positive list are presented in the *Carbon Credits (Carbon Farming Initiative) Act 2011.* The positive list will be included in the CFI regulations and eventually give a long list of approved activities, making it easier to identify possibilities for future projects.

The negative list identifies activities that will not be eligible for CFI projects because of the risk of adverse impacts. This will ensure that risks that are not addressed in other regulation or existing planning will be managed properly. It includes activities which will have a negative impact on:

- Water availability
- Biodiversity
- Employment
- The local community
- Land available for agricultural production.

These lists will form a source of information for landholders who consider undertaking a CFI project. The negative and positive lists can change over time due to technological development and scientific research and can also be geographically dependent. Activities that become common practice because of the CFI scheme will, however, not be removed from the positive list.

3.8 Complementary benefits

A special need to protect Australia's unique biodiversity has lead to the establishment of the Biodiversity Fund to complement the CFI scheme. The fund aims to support carbon storage projects in areas of high conservation value, projects for management and protection of biodiverse ecosystems and action to prevent spread of invasive species. The fund is ongoing and will provide funding of $946 million over the first six years for landholders to undertake relevant projects (DCCEE, 2011a).

The Regional Natural Resource Management Planning for Climate Change Fund will help regional communities plan for climate change, maximise the benefits of the CFI scheme and develop climate change scenarios. These measures will help to identify target areas for the Biodiversity Fund (DCCEE, 2012f).

4 Abatement and sequestration potential

Agriculture and forestry are accountable for about 18 per cent of Australia's total emissions, and the potential for mitigation and sequestration is large (DAFF, 2012a). The CFI scheme therefore seeks to include agriculture and forestry in the carbon market and abatement activities.

Credits can be earned from activities including:

- Reforestation, afforestation and revegetation
- Reduced methane emissions from livestock
- Reduced fertiliser pollution
- Manure management
- Reduced pollution or increased carbon storage in soils
- Savanna fire management
- Native forest protection
- Forest management
- Reduced pollution from burning of stubble and crop residue
- Reduced pollution from rice cultivation
- Reduced pollution from legacy landfill waste (deposited before 1 July 2011).

For farmers and landowners to be a part of the CFI scheme, they will have to investigate the potential for either reducing emissions or sequestering carbon. Each farm business will have different potential and opportunities, and will need to assess the costs and benefits of developing a CFI project.

In 2008, the Garnaut Climate Change Review presented estimates for abatement and sequestration potential (Garnaut, 2008a). In 2009, CSIRO undertook an in-depth assessment to estimate the realistic potential for abatement and sequestration (CSIRO, 2009). The results are presented in table 2. There are large uncertainties about the figures and the amount of realistic potential but it is clear that the land sector holds a significant amount of abatement and sequestration potential. A realisation of a small part of the potential abatement and sequestration can make a large contribution towards cutting Australian emissions (CSIRO, 2009; Garnaut, 2011). Australia's total emissions for 2010/2011 were 546 Mt/CO_2-e, which highlights the extent of the CFI scheme's potential (DCCEE, 2011b).

The high level of uncertainty is related to biological, technical and implementation measures. With the implementation of the *Carbon Pricing Scheme* the requirement for carbon credits will be established and drive demand.

The technical potential for Queensland is estimated to be 293 Mt/CO_2-e /yr (CSIRO, 2009), of which 140 Mt/CO_2-e /yr is classed attainable with concerted efforts. For forestry, the carbon storage potential in Queensland represents 105 Mt/CO_2-e /yr; this includes forestry, biodiversity plantings, commercial forest plantations and reduced/managed regeneration. For agriculture, it is estimated that 26 Mt/CO_2-e /yr is attainable through mitigation and sequestration (CSIRO, 2009).

Table 2: Estimates of abatement and sequestration potential extracted from Garnaut (2008a) and CSIRO (2009).

CFI options	National potential Mt/CO_2-e /yr	
	Garnaut (2008)	CSIRO (2009)
Agriculture		
Rehabilitate overgrazed rangeland, restoring carbon balance in soil and vegetation	286	100
Mitigation of emissions from savanna burning	5	13
Build soil carbon and mitigate N_2O for cropped land	68	25
Reduce livestock enteric emissions and structural change in industry	16	26
Forestry		
Change land use to carbon forestry (primary for carbon sequestration)	143	750
Carbon positive management of regrowth vegetation and remnant forest (reduce land clearing)	63	56
Bioenergy		
Stabilise organic carbon in biochar and store in soil	Not estimated	9

5 Methodology development

A methodology for a CFI project describes the eligible abatement activities and must include:

- A description of abatement activities, GHGs, emission sources and sinks relevant to the project
- A determination of a baseline to provide information of the level of emissions abatement and/or sequestration that directly results from the project (as opposed to business as usual). Normally, one of three different methods is used: historical, projected or comparison
- Information and models for estimating or measuring of abatements
- Data collection and monitoring requirements specific to the project
- Specific reporting and record requirements additional to CFI regulation
- Supporting evidence outlining that the methodology is consistent with offsets criteria.

DCCE provides detailed guidelines to facilitate the development of new methodologies (DCCEE, 2012g). To apply for approval of a new methodology, the scope of the methodology needs to be defined including activities, technologies and management practices to be implemented. The methodology must be non project specific, so that it can be applied to other projects and thus minimise the need for individuals to develop new methodologies.

Description of climatic and environmental conditions is necessary, although these cannot be state-specific, refer to state jurisdiction or regional boundaries. The methodology must also include a greenhouse gas assessment boundary which will identify the boundaries of the GHG effect within the project. These boundaries should include all emissions sources and sinks directly or indirectly affected by the project. Procedures for estimating abatements have to be clearly defined and all formulas should be included in the methodology proposal. The National Greenhouse and Energy Reporting System (NGERS) and Australia's National Greenhouse Accounts have already established protocols for estimating GHG emissions. These can be used in a CFI methodology or new can be developed with appropriate credible scientific evidence. Bio-sequestration projects often have a high level of variability, which will have to be accounted for by finding an average level of carbon stocks.

Methodologies that have been approved and are available to be employed in other projects will be available on DCCEE's website: (http://www.climatechange.gov.au/en/government/initiatives/carbon-farming-initiative/methodology-development/approved-methodologies.aspx).

If a project proponent believes that a new methodology is necessary, although similar to an existing approved methodology, explanation of the differences will be required.

5.1 Support for research

The Department of Agriculture, Fisheries and Forestry (DAFF) has launched a number of funding initiatives as part of the *Carbon Farming Futures* program. The *Filling the Research Gap* program ($201 million) will support research into activities that reduce emissions of greenhouse gases from the land sector, including emerging abatement technologies and innovative management practices. These research outcomes will facilitate the development of new CFI methodologies. The *Action on the Ground* program ($99 million) will fund projects that trial and demonstrate practices and technologies which reduce emissions or increase carbon stored in soil. These projects will ensure that the practices and technologies can be

applied practically on-farm, and should increase the adoption of improved practices by farmers and landowners.

The first round of grants worth $72.5 million has been approved and the following projects may provide results relevant to the horticultural industry:

Filling the Research Gap:

- Research into mitigation of indirect greenhouse gases in intensive agricultural production systems with the use of inhibitors

Action on the Ground:

- Best management practices of carbon management on Northern Rivers farms
- Evaluation of soil ameliorates with strong potential to reduce nitrous oxide emissions
- Horticulture: taking action to capture carbon and reduce nitrous oxide emissions
- Reducing greenhouse gas emissions through improved nitrogen management on NT farms
- Improved fertiliser and soil management in South East Queensland intensive horticulture
- Enhanced compost trials on cane and tree crops on the Sunshine Coast
- Nitrous oxide reduction and soil carbon increase in tropical fruit tree crops

Further funding rounds will support additional projects that will assist in the development of methodologies that can be applied by horticultural producers.

6 Opportunities for horticulture

When investigating CFI projects applicable for the horticultural sector, it is important to consider that the project must be compatible with ongoing intensive food production so as to not compromise future production. Most of the proposed CFI methodologies are mainly suitable for extensive farming operations such as grazing and broadacre. In contrast to these farming practices, horticulture relies heavily on intensive production on relatively small areas of high quality land. In horticultural industries, it is therefore difficult to set aside land for other uses without a considerable cut in production.

6.1 Environmental plantings

Carbon sequestration in environmental plantings is the most commonly used carbon offset methodology. Approximately half of a tree's dry biomass is carbon, but the storage capacity varies with species, soil quality, climatic conditions and land management practices. Besides the benefits of removing carbon from the atmosphere, environmental plantings have additional benefits such as salinity and erosion control, water purification and creation of wildlife habitat (Department of Industry & Investment NSW, 2010). Environmental plantings can also be designed to function as windbreak, borders, pest management or habitats for pollinators and in that way provide other positive benefits for the farm (SARDI, 2008).

Well-established methodologies and accounting methods are available, and environmental plantings are considered to be an efficient method to remove carbon from the atmosphere. CSIRO has estimated sequestration potential for land-use change to carbon forestry to be 750 Mt/CO_2-e/yr in Australia (table 2). However, not all of this will be considered realistically achievable; in a more detailed study on Queensland, the sequestration potential was found to be 153 Mt/CO_2-e/yr, of which around half, 77 Mt/CO_2-e/yr, was found to be realistically achievable (CSIRO, 2009). But even half of the potential of 750 Mt/CO_2-e/yr for Australia will offset a large part of Australia's total emissions of 546 Mt/CO_2-e/yr.

6.1.1 Methodology for environmental plantings

Under the CFI methodology, environmental plantings are defined as the establishment of permanent environmental plantings of native species for carbon sequestration. DCCEE's Methodology Development Team has developed the methodology with technical assistance from divisions under DCCEE, The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) and DAFF (DCCEE, 2011c).

The developed methodology for environmental plantings requires the species planted to be native to the area and have potential for a height of at least two metres with a crown cover of 20 per cent to comply with international standards. Table 3 shows the minimum number of trees required for different crown diameters.

Table 3: Number of trees/ha required for different crown diameter (DCCEE, 2011c).

Mature crown diameter (m)	Minimum number of trees/ha required for 20% crown cover
5.0	102
4.5	126
4.0	159
3.5	208
3.0	283
2.5	407
2.0	637

6.1.2 Requirements

The following requirements apply to the environmental planting methodology:

- Species used in environmental plantings have to be native to the local area. It can be a mix of trees and understory species or a single species monoculture if such occur naturally in the area
- Plantings may be established through direct seeding or planting
- Harvesting of wood products is not permitted, with a maximum of 10 per cent debris removal per year. Some thinning is allowed to promote forest health but biomass must remain on site
- No grazing by livestock is allowed for the first three years
- The land must have been cleared at least five years prior to planting or seeding. If the area would naturally convert to forest without the project, it is not eligible for obtaining carbon credits
- Ripping and mounding must not exceed 10 per cent of the area
- Invasive native scrub species or woody biomass cannot be cleared; only weed species mandated by law can be cleared to undertake the project.

6.1.3 Modeling tools

Three modeling tools can be used by a project proponent to manage and monitor the project:

- The Australian Government's Reforestation Modeling Tool (RMT)
- CFI Mapping tool (developed by DCCEE)
- Reforestation Abatement Calculator (developed by DCCEE) (DCCEE, 2011c).

The tools can be accessed by registering on DCCEE's website: (http://ncat.climatechange.gov.au/cfirefor/).

The RMT is a computer model based on inputs of species, management and disturbance events. The model can estimate greenhouse gas emissions and removals of carbon pools, and is frequently updated with the latest research findings.

The CFI mapping tool can define the geographic areas to assist in the management of geographic boundaries of environmental planting projects.

The Reforestation Abatement Calculator can record data and calculate abatements with details on aggregate abatements, non-carbon emissions from fire, project emissions and net abatement.

6.1.4 Estimating the baseline

In order to calculate the abatement achieved by implementing the project, a baseline abatement level must be estimated (i.e. the level of abatement or sequestration that would have occurred in the absence of the project). Under this methodology, the baseline scenario is defined by the emissions or sequestration that would occur under continuation of the last five years' dominant land use. Under the requirements of the project, it is assumed that no natural regrowth would occur without establishment of the project and the baseline is therefore set to zero carbon stock exchange. Removal of weed species required by law will not count as emissions from the project, as they will be considered under the baseline conditions.

The following emissions and sinks are included under the project's boundaries:

- Live biomass above and below ground
- Dead plant material and debris
- Fuel use in relation to the project
- Thinning of vegetation (need to be left on site)
- Removal of firewood (less than ten per cent)
- Fires (both controlled and uncontrolled).

The last three emission sources must be entered to the RMT to ensure accurate calculations of emissions to be included in the project.

All other emissions and sinks are considered to be insignificant or approximately equal to what would happen without the project.

6.1.5 Monitoring, reporting and records

To ensure that a project continues to meet the requirements defined in the methodology, ground observations and/or satellite images can be used to monitor activities, practices and abatement.

In addition to the general reporting requirements required under the CFI scheme, project proponents must also report on:

- Forest management
- Project areas
- Abatement estimates.

6.1.6 Opportunities on horticultural land

Carbon sequestration by permanent environmental plantings is the only currently approved methodology that may be relevant for horticultural producers. However, the opportunities on horticulture land are considered to be limited because of the character of most horticultural farms which operate with intensive production of high value commodities on relatively small areas of high quality land. Most fruit and vegetable growers will therefore have a higher return rate with traditional commodities than carbon farming.

However, it could be beneficial to consider potential non-financial benefits to the farm. For example, environmental plantings can be placed strategically and double as windbreaks or visual screens while providing environmental benefits as mentioned earlier in section 5.1. These non-financial benefits should be considered when assessing land suitable for generating credits under the CFI scheme.

6.1.7 Credits

Land areas which have been cleared before 31st of December 1989 will be eligible for Kyoto compliant carbon credits. For areas that have been cleared after 1989 but have been clear of forest for at least five years before the start of the project, obtained credits will be non-Kyoto compliant and only eligible for the volunteer market.

6.1.8 Costs related to environmental plantings projects

A thorough audit of the land and current practices is required before starting an environmental plantings CFI project. A number of companies offer support for this process including planning, regulatory and on-site activities. To our knowledge, no CFI project has been initiated on horticultural farms at this time, so the costs related to the preliminary assessments are not known.

However, a number of projects are already running though on land areas significantly larger than a typical horticultural farm. The size, location and complexity of the project are all factors which influence the final price for the preliminary assessment. One company which assists landowners with the procedure of registering and auditing projects based on environmental plantings estimates that the costs are in the area of $20,000 for each property. However, these properties are mostly several thousand hectares in area. The cost for smaller land areas should be somewhat lower, but fixed costs related to the preliminary assessment and project management will be the same regardless of project size.

The carbon sequestration potential is important to estimate the likely return rate from an environmental plantings project. Current environmental plantings projects sequester between 7-15 t/ha/yr depending on species and location. Until July 2015, the carbon price is fixed and each tonne of carbon should generate a credit worth $23 (increasing with 2.5 per cent each year). At this carbon price, the potential return from a project based on this methodology ranges between approximately $160 and $345/ha/yr.

At this time, all figures are only estimates which make it very difficult to develop a reliable budget for a CFI project on horticultural land.

6.2 Fertiliser management

Nitrous oxide (N_2O) accounts for 23 per cent of greenhouse gas emissions from agriculture in Australia. One of the most common sources of N_2O emissions is from fertiliser use. N_2O has a global warming potential 310 times higher than CO_2. As a result, reducing N_2O emissions will make an important contribution to mitigating Australia's greenhouse gas emissions.

The best options for horticulture farmers to earn carbon credits under the CFI scheme seem to lay in mitigation of N_2O emissions via improved fertiliser management such as increased efficiency, reduced application rates, improved application methods, and nitrification inhibitors. The aim will be to maintain production levels while reducing the amount of fertiliser needed or minimising emissions from fertiliser applied. DCCEE has formed a *Nitrous Oxide Technical Working Group* and a *Soils Technical Steering Group* to monitor recent scientific advances that may facilitate the development of new methodologies and identify priority research needs.

6.2.1 Methodology for fertiliser management

Fertiliser management can reduce the level of N_2O emissions resulting from the application of nitrogen fertilisers. For example, the application of urease or nitrification inhibitors to, or with, livestock manure or fertiliser, is included on the positive list of eligible activities (DCCEE, 2012h). Other management options include reduced application rates, split applications, subsurface applications, and improved soil testing to better match fertiliser application with the crop's requirements.

However, draft methodologies are still in preparation.

6.2.2 Opportunities on horticultural land

The *Climate Change Research Program* (CCRP; Department of Agriculture, Fisheries and Forestry) is funding a number of projects exploring the potential of fertiliser management to minimise emissions of N_2O. Preliminary results from one of these projects in Southeast Queensland has shown that rates of emissions following the application of fertilisers at reduced rates or with nitrification inhibitors can be significantly lower than standard practices. Average reductions in N_2O emissions of around 40 per cent have been recorded, although there is enormous variation depending on several other factors. However, the low absolute rate of emissions and the small land area involved in most horticultural enterprise results in a low total abatement at a property level. For example, these preliminary results from Queensland indicate that nitrification inhibitors may result in an average reduction in N_2O emissions of about 8.8kg/ha/yr, or about 2.6 tonnes of carbon dioxide equivalents per hectare per year. Fertiliser management would meet the Kyoto Protocol requirements and be eligible for Compliance ACCUs. At a carbon price of $23/tonne, that equates to a potential gross return of about $60 per hectare per year without considering the costs of participation.

The *Nitrous Oxide Technical Working Group* (DCCEE) is exploring potential methodologies for reductions of N_2O emissions. To date, the effort has been concentrated on broadacre cropping and grazing systems. As with the results from trials on horticulture in Queensland, the available data suggests that potential returns from the use of inhibitors will be low.

More research is required to assess the potential abatement from fertiliser management across horticulture, and particularly the potential for fertiliser management to form the basis of a CFI methodology. Several projects funded under the first rounds of *Filling the Research Gap* and *Action on the Ground* programs are designed to address this issue. In addition, other research organisations are in the process of developing CFI methodologies, some specifically for horticulture. However, it is likely to be some time before these methodologies are approved and available for application on farm.

In addition, the CFI regulations limit the possible income across the sector depending on the maximum abatement potential. According to the National Greenhouse Gas Inventory (Department of Climate Change, 2007), the horticulture industry contributes approximately 1 million tonnes of CO_2-e per year. If the industry could cut all greenhouse emissions to zero *and* obtain credit for the whole amount under the CFI, the maximum potential income across the entire sector would be approximately $25 million per year (at a carbon price of $25/tonne CO_2-e). That equates to an average of about $1110 per year per farm business (less the costs associated with participation in the initiative), or less than 0.4 per cent of the value of agricultural production for the horticulture sector.

The lack of a detailed methodology means that it is currently very difficult to conduct a robust assessment of the opportunities that these activities may offer growers and the costs involved in conducting these projects. However, the information available at this time suggests that the income potential is low.

6.3 Soil carbon

Another carbon sequestration opportunity lays in sequestering carbon in soil. Soil carbon levels can be raised through a number of methods, including the incorporation of crop residues, reduced tillage, humus and charcoal. Higher carbon levels in soil can result in a number of benefits beside carbon sequestration such as increased soil moisture, nutrient levels, pH level and fertiliser efficiency. Nutrient poor and/or acidic sites in particular may benefit from the application of charcoal in the form of biochar (Department of Industry & Investment NSW, 2009).

Increased soil carbon can be gained through improved land management. Measures to increase carbon in soils include biochar application, changes in tillage practices or amendments in compost and organic matter.

While there is significant potential for soil carbon sequestration, methodologies to enable and support projects have not been developed at this time.

6.3.1 Biochar

Biochar is produced by heating plant or animal materials to high temperatures (350-600°C) under low oxygen conditions. Depending on the production method, surface to volume ratio of the particles, soil conditions and climate, biochar can be very stable and meet the permanency requirements for sequestration projects under the CFI scheme. When biochar has been applied to the soil, it is resistant to degradation or removal and will comply with the required permanence obligations (Verheijen et al., 2010).

By adding biochar to soil, the carbon input to soil will increase significantly, while the output may decrease (Verheijen et al., 2010). The sequestration potential for soil carbon has been estimated at up to 68 Mt/CO_2-e/yr (Garnaut, 2008b), while CSIRO has a significant lower

estimate of 25 Mt/CO_2-e/yr. The large divergence lays in the fact that Garnaut included all cropping land, while CSIRO only included annually cropped soils (CSIRO, 2009). There is some evidence that soil treated with biochar has the potential to maintain crop yield with ten per cent less fertiliser than normally applied and increase plants' uptake of a number of nutrients. Biochar can also increase the soils capacity to hold moisture (Sohi et al., 2009).

However, biochar application can also have some negative impacts, with the main disadvantage being an increased risk of erosion. Other potential negative impacts include compaction and contamination risks and decrease in earthworm survival under excessive biochar application with decreased soil health as a consequence. Removal of crop residues from soil for biochar production can also have negative impact on soil health. Planning and management are required to mitigate these impacts if biochar projects are undertaken (Verheijen et al., 2010).

6.3.2 Reduced tillage

Another method that can be used to increase soil carbon is reduced tillage. When soil is ploughed, much of the organic matter becomes exposed and carbon is lost to the atmosphere. The amount of carbon lost increases with the depth of loosened soil (Sundermeier et al., 2004). Reducing the depth of tillage and/or frequency will therefore build up organic matter in the soil and increase soil carbon levels. This will also have beneficial effects on soil quality and soil moisture while reducing the risk of erosion (Sundermeier et al., 2004; Dumanski et al., 2006).

6.3.3 Methodologies for soil carbon

Application of biochar to soil is included on the positive list for CFI projects (DCCEE, 2012h). However, there is currently no approved methodology for such projects.

When a sequestration methodology is developed for the application of biochar, it will include permanence obligations which will ensure that the carbon stays in the soil for at least 100 years. As a result, the application of biochar and participation in CFI will have long-term consequences for farm management. If circumstances require a change in land management, it is possible for landholders to cancel a project by handing over the former acquired credits, which can be purchased on the existing market (DAFF, 2012b).

Soil carbon sequestration is not compliant with the Kyoto Protocol. Credits generated via soil carbon sequestration will be suitable only for the voluntary market and will gain a much lower price than Kyoto-compliant credits.

Reduced tillage is not currently on the positive list but it is mentioned as an example of storing carbon in soil under the Clean Energy Future CFI scheme (Australian Government, 2012). Reduced tillage is already widely adopted in some agricultural businesses. Worldwide, zero tillage is practiced on 95 million hectares and nine per cent of this area is in Australia (Dumanski et al., 2006). However, areas and farming businesses where reduced tillage is not already common practice could be considered for the CFI methodology.

6.3.4 Opportunities on horticultural land

The high price of biochar is currently a strong factor limiting its application in farming systems. Applying biochar to soil can sequester about 2.2 t/ha and will cost approximately $682 per tonne in biochar (da Silva, 2012). The sequestration rate and price of biochar will vary greatly with the type of biochar, soil quality and climatic conditions. However, it seems that the potential return rate will be far lower than the costs related to biochar applications and it is unlikely that the potential benefits to crop yield and soil moisture will make up for the costs. Furthermore, because the credits generated from biochar application will be non-Kyoto-compliant and therefore only for sale on the voluntary market, the credits could gain a price as low as $3 per tonne CO_2-e (DCCEE, 2012c).

Because of the requirements of methodologies for the CFI scheme to be beyond common practice, a methodology for reduced tillage would exclude land areas with tree crops which naturally practice no tillage. However, annual crop growers might be able to alter tillage management and thereby increase soil carbon. Research in cropping regions in south eastern Australia shows an increase in carbon soil as well as a decrease in associated carbon emissions (fuel use, fertiliser etc). Carbon emissions decreased 14 per cent going from normal practice to reduced tillage and further 10 per cent going to zero tillage systems. Soil carbon increased from 0.6 to 6 tonnes of carbon per hectare under reduced tillage and up to 12.7 tonnes per hectare under zero tillage practice. The study also concluded that even under a carbon price of $50 per tonne of carbon, the economic incentive would be minimal (Grace, 2007).

7 Proposed methodologies

A number of proposals for new methodologies are currently under consideration with DOIC. The methodologies are now either open for public comments or being reviewed by DOIC.

The methodologies proposed which could be applicable to horticultural producers are briefly presented in the following sections. They are both similar to the environmental plantings methodology, in terms of setting aside land to plant trees for carbon sequestration. However, the requirements for species planted and technical details differ.

7.1 Afforestation and reforestation

The proposed methodology for afforestation and reforestation is a carbon storage methodology based on sequestering carbon in forests. Reforestation refers to active replanting of forest in an area which historically has been cleared from forest with the main purpose of establishing an agricultural production system. Afforestation is referring to replanting in agricultural areas naturally clear of forest. It is required that the area has been free from trees and the dominant use has been agricultural production in the five years prior to commencement of the project. The new forest can consist of single species or a mix of tree species.

7.2 Farm forestry projects

Another similar methodology has been proposed; Measurement based Methodology for Farm Forestry Projects. This project is also building on carbon sequestration via tree plantings. The requirements are that the area planted should at least have been clear of forest five years prior to start of the project and that no natural revegetation would occur under current land-use. This methodology also applies plantings of both single and mixed species.

The main difference for this methodology compared to environmental plantings and afforestation/reforestation methodologies lays in the opportunity to harvest the forest. This will naturally provide a lower level of carbon sequestration that will be accounted for in the number of credits acquired. However, it is suggested that the species selected for harvest may be more rapid growing and thereby make up for some of the loss in average carbon sequestration levels.

This methodology will open some possibilities for income from production forestry along with the intended revenue from carbon credits.

7.3 Opportunities on horticultural land

Afforestation and reforestation are seen to have limited opportunities for horticultural producers. The methodology is closely related to the already approved environmental plantings methodology and the same obstacles occur. These are related to the relatively small land areas with horticultural production, the high quality of the land and value of horticultural production. However, also under this methodology some strategically placed trees can have additional benefits and function as windbreaks or visual screens.

It is important to note that the afforestation/reforestation and forestry methodologies are still being review by DOIC and are therefore not yet approved CFI methodologies.

8 Costs related to CFI projects

Unfortunately, there is currently little information available on the costs of participation in CFI projects. The costs of implementing a project will be dependent on the methodology used. Given that there are currently no methodologies compatible with horticultural production (either approved or proposed), it is not possible to calculate costs of implementation. In addition, the costs associated with project registration, measurement, verification and auditing are likely to be considerable. More reliable information on these costs will be available once more producers in other industries commence CFI projects using the existing methodologies.

An environmental plantings project is estimated to cost around $20,000 for each property. The potential income is in the range of $160-345/ha/yr in the fixed carbon price period. These numbers indicate that the methodology is mainly profitable for large scale farms which have a large land area with a relatively low per hectare income.

The high levels of uncertainty on key measures such as mitigation and sequestration potential, income that can be obtained from acquired credits and costs related to the project, make it difficult for growers to take the decision and undertake a CFI project.

9 Implications of the CFI

With limited opportunities for horticultural producers under the CFI it is unlikely that the scheme will be widely adopted in the horticultural industry. This will limit the risk of land-use changes on areas under horticultural production and thereby potential negative implications on future food security.

10 Conclusions

The agricultural sector is accountable for almost one fifth of Australia's greenhouse gas (GHG) emissions and therefore has considerable potential to play crucial role in the process of cutting national emissions.

The *Carbon Farming Initiative* (CFI) will provide opportunities for the agricultural industry to be a part of the emerging carbon market. Farmers and landowners can earn carbon credits by undertaking projects that will mitigate or sequester greenhouse gasses. The projects must be additional to business as usual to become a recognised CFI project.

To undertake a project, the applicant has to be a Recognised Offset Entity and the project needs to employ an approved methodology. A methodology describes the activities that will be undertaken, rules for implementation, methods for monitoring, and estimates of baseline emissions. The project will need approval by the Carbon Credits Administrator. When undertaking a project, monitoring and reporting are required to acquire credits. Approved methodologies and projects will be publicly available and will give farmers and landowners inspiration for potential projects.

Two types of credits can be acquired, compliance and voluntary, depending on the type of project undertaken. Compliance credits can be sold to businesses with liabilities under the domestic carbon price. They are also compatible with international standards under the Kyoto Protocol and can therefore be sold on the international market to businesses and countries with requirements under the Kyoto Protocol. Several countries and states have schemes similar to the Australian carbon price mechanism and they will be a part of the international carbon market. However, national requirements can disqualify some type of credits generated under the CFI scheme. Voluntary credits are likely to be sold to businesses or organisations which are environmentally concerned or want to lower their carbon footprint for promotional reasons.

The potential for reductions or sequestration of GHG emissions has been investigated by Garnaut (2008a) and the CSIRO (2009); however, a high level of uncertainty and different definitions lead to variable conclusions. While realistic levels of attainable abatement and sequestration may be considerable lower than the technical potential, the amount of greenhouse gases that can be sequestered or mitigated in the land sector will be a substantial contribution to national abatement.

The potential for the horticultural sector to participate in the CFI is considered to be considerably lower than that for other agricultural businesses. Horticulture is characterised by intensive production of high value products on small land areas compared to other agricultural businesses. The most promising type of CFI project seems to be mitigation of nitrous oxide emissions from improved fertiliser management. However, projects such as reforestation, revegetation and carbon soil sequestration may also provide opportunities for some growers.

Uncertainties about the carbon market, demand, prices, requirements for credits, abatement and sequestration potential, and international negotiations make it difficult to estimate the actual economic potential for horticulture at this time.

The only approved methodology currently available that could be integrated into horticultural production is based on environmental plantings. These projects will gain Kyoto-compliant carbon credits from carbon stored in native environmental plantings. If such a project is started under the CFI scheme, it has a permanency requirement which ensures the carbon

will remain stored for at least 100 years. Only areas that have been cleared for at least five years without potential regrowth will be approved for the project.

To date, we have no knowledge of a project based on environmental plantings being initiated on horticultural farms. As a result, the costs related to the start-up phase and management of these projects on horticultural land are not known. Estimates of initial costs and carbon sequestration rates from current projects in other agricultural systems suggest a potential return rate between $160 and $345/ha/yr with start up costs in the area of $20,000.

Available information suggests that opportunities for horticultural producers are probably limited. Environmental plantings could be used as windbreaks or visual screens and thereby provide additional benefits to the farm.

Fertiliser management is another potential greenhouse gas abatement method on the CFI positive list, but no methodology has yet been developed. Fertiliser management include application of urease or nitrification inhibitors, reduced application rates, split applications, subsurface applications and improved soil testing.

Preliminary research at the Granite Belt in Queensland suggests potential abatement levels of about 2.6 tonnes CO_2-e/ha/yr, but the lack of a methodology and sufficient research makes it difficult to assess the opportunities for these activities.

A number of methods can be used to increase soil carbon. Application of biochar is currently on the positive list of activities. Biochar can be applied to soil and increase the amount of organic matter and thereby carbon sequestered in the soil. The amount of carbon which can be stored differ largely due to location and climate. One study suggests 2.2 t/ha, but the cost of biochar will by far exceed the potential return rate from carbon credits. Reduced tillage is another method for increased soil carbon levels. This practice is commonly used worldwide with Australian analyses showing carbon sequestration from 0.6-12.7 t/ha, with the large range resulting from differences in location, climate and reduced or zero tillage practices. In addition, credits generated through soil carbon projects are non-Kyoto-compliant and therefore sell for a lower price.

A number of proposed methodologies are currently being assessed. Only a few of these will be compatible with horticulture; these include afforestation, reforestation and farm forestry projects. The projects are similar in concept to the approved methodology for environmental plantings. The new methodologies will therefore only provide the same limited opportunities for horticultural producers as the environmental plantings methodology.

A number of projects that are likely to produce information that will assist in the development of methodologies have received funding under the Carbon Farming Futures program. However, it is likely to be some times before the results of these programs can be directly applied on horticultural farms.

Available information on the economics of CFI projects is very limited which makes it difficult to investigate the cost and income potential for horticultural growers at this time. Once more producers in other industries undertake CFI projects additional information will be available to research the economic opportunities for the horticultural industry.

At this stage, many unknown factors make it difficult to thoroughly assess the potential for the horticulture in the CFI scheme. Small areas of environmental plantings or, further down the track, biochar and fertiliser management, might provide some income through the generation of carbon credits but currently the potential income is low.

11 Definitions

AAU	Assigned Amounts Units
ACCU	Australian Carbon Credit Unit
CCA	Carbon Credits Administrator
CFI	Carbon Farming Initiative
CFI methodology	An approved methodology describes the activities that will be undertaken, rules for implementation, methods for monitoring, and estimates of baseline emissions
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture Fisheries and Forestry
DCCEE	Department of Climate Change and Energy Efficiency
DOIC	Domestic Offsets Integrity Committee
ETS	Emissions Trading Scheme
GHG	Greenhouse Gas: Gases in the atmosphere that absorb and emit radiation and causes warming of the atmosphere
GWP	Global Warming Potential: A greenhouse gas' potential for warming of the atmosphere based on the time the gas will remain in the atmosphere and its ability to absorb heath expressed in units CO_2-e
Mitigation	Changes in procedures and technologies to reduce GHG emission per unit of output
N_2O	Nitrous oxide
Sequestration	Storage of carbon in the environment in forests, soil, oceans etc.

Sources: (IPCC, 2008; DCCEE, 2012i)

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