Engineered Woodlands

Information Sheet 3

Carbon Trading

Engineered woodlands are wide-spaced tree plantings engineered to integrate traditional agriculture with income-producing trees. A whole of paddock approach is taken to place trees to maximise their benefits to the landscape and minimise the impact on paddock management.

Benefits

- Shade and shelter for better livestock, crop and pasture production
- Better habitat for biodiversity
- Improved soil nutrient cycling and water use efficiency
- Income from timber and carbon credits
- Improved landscape aesthetics.

Key features

- Designed to produce multiple products from both the traditional agriculture as well as the trees.
- The use of entire paddocks for tree establishment minimises fencing costs, and substantially reduces establishment costs.
- Agricultural activity can continue between belts once trees are sufficiently established (within 1-3 years for most sites).
- Tree belts or copses (clusters of trees) are established at spacings to suit machinery, pasture and stock management, and are aligned to maximise microclimate benefits.

This information sheet provides landholders with basic information on carbon trading and the opportunities for storing carbon in engineered woodlands. The information on carbon trading schemes and carbon credit providers is necessarily brief, and readers are referred to the appended glossary and the external references mentioned in the text for more detailed information.

Society's response to climate change

Most landholders are aware that governments and most climate scientists around the world expect significant climate change in coming decades. Climate change is believed to have resulted from an increase in the concentration of a number of gases in the atmosphere (so called 'greenhouse gases'). This increase is credited to a number of human activities, but primarily due to the burning of coal, oil and gas for energy and transport. Carbon dioxide (CO_2) is the main gas emitted when fossil fuels are burnt and is the principal greenhouse gas of concern. Governments believe that unless human society can reduce the emission of greenhouse gases, there is a grave risk of catastrophic climate change which could have significant economic and social impacts around the globe.

To reduce the emissions of CO_2, industry and society must either:

1. dramatically reduce energy consumption and/or
2. use energy sources that do not release greenhouse gases (e.g. renewable energy sources such as solar, wind and tidal power) and/or
3. offset the emissions by removing CO_2 from the atmosphere and storing it in a different non-polluting form (carbon sinks).

Below: Power stations and transport are by far the largest source of human-induced greenhouse gas emissions.

Above: New tree plantings can act as greenhouse gas sinks that capture CO_2 and offset emissions from other sources.

The Kyoto Rules

A forest sink (tree planting) must meet certain rules or criteria to qualify as suitable for generating carbon credits. The criteria vary from scheme to scheme but are usually based on a number of rules internationally agreed upon under the Kyoto Protocol. These are:

1. The site must have been predominantly clear of vegetation on 31 December 1989
2. The site must have been revegetated after 1 January 1990
3. The site must have been revegetated by seeding, planting or other human action
4. The vegetation must attain a height of at least two metres
5. The vegetation's top layer must reach a crown cover of greater than 20 per cent
6. The site must be at least 0.2 ha and 10 m wide
7. The carbon will remain on site for at least 100 years.

Some carbon trading organisations may have additional rules, or operate in the voluntary carbon market with different eligibility criteria.

To encourage industry to reduce greenhouse gas emissions, many governments have established, or are planning to introduce (e.g. Australia), emissions trading schemes. New South Wales has had a Greenhouse Gas Abatement Scheme—GGAS—operating for large scale emitters since 2003.

In such schemes, a cap on the amount of greenhouse gases that an industry can emit is established by Government. Permits-to-emit equivalent to the capped level are distributed or sold to industry. If a business emits greenhouse gases at levels exceeding the amount of permits it owns (or has been allocated), the business is then obliged either to buy more permits in the carbon market for each tonne of excess carbon dioxide equivalents ($CO_{2\text{-e}}$) it has emitted, or face a penalty. $CO_{2\text{-e}}$ are the units of measurement used in carbon trading.

Permits, or more colloquially 'Carbon Credits', can be provided by other organisations which remove greenhouse gases from the atmosphere. Indeed, a whole marketplace of carbon credit providers and brokers has already established itself. This marketplace is expected to evolve further when Australia's national Carbon Pollution Reduction Scheme (CPRS) comes into force in a few years time.

For more detailed information on climate change, greenhouse gas emissions, the carbon cycle, forest sinks and emissions trading, visit *www.greenhouse.gov.au* and *www.plantation2020.com.au.*

The opportunity for landholders to trade carbon

As they grow, woody plants convert atmospheric carbon dioxide (CO_2) into woody tissue via the process of photosynthesis. The conversion of this atmospheric CO_2 into carbon compounds in the plant is called 'sequestration'. The end result is that carbon is removed from the atmosphere.

Tree plantings intended to be used to sequester carbon are known as 'forest sinks' regardless of the species used and the pattern and density of planting.

Tree plantings are therefore a way for landholders to participate in the carbon market and potentially receive income from 'carbon credits'.

Landholders wishing to do this would normally require the services of a carbon trading company or carbon offset provider. These service providers will 'package' the carbon being sequestered in your planting into an appropriate form to be offered for sale in a carbon trading scheme.

'Packaging' may require:

1. ensuring the forest sink is eligible under the rules of a relevant trading scheme
2. appropriately identifying the land parcel the trees are established upon
3. legal work on agreements that identify carbon trading, *forest right* agreements and any *restriction on use* agreements that may covenant the land for a carbon liability (see page 3)
4. generating 'abatement certificates' or 'permits' (carbon credits) in a tradable form and if required, offering these in the open market or to known carbon credit buyers
5. having accredited capacity to measure and/or model the amount of carbon stored in the forest sink over time, and conducting periodic audits to validate the carbon credits sold
6. keeping required records and reporting on the progress of the forest sink at least once every five years.

Some organisations only seek land to establish their own forest sinks and do all of the project development from ground preparation and tree planting to carbon sales. These companies may offer lease or income sharing arrangements with the landholder.

Landholders should note that in

accredited carbon trading schemes, carbon credits can only be claimed:

- *after* the carbon has been sequestered, and
- on the *additional* amount sequestered during the previous year (not the total amount accumulated).

Interested landholders should contact carbon trading organisations directly to determine the available services and the rules under which a carbon sink (forest sink) must operate. The website *www.carbonoffsetguide.com.au/providers* lists the contact details of many of the current carbon trading organisations operating in Australia.

Carbon sequestration & carbon liabilities

Any given parcel of land suitable for tree planting has an upper limit on the amount of vegetation (biomass) that can be supported per hectare. Therefore, there is also an upper limit on the amount of carbon that can be stored in the trees on the site. Once a planting reaches the site's upper limit, no more additional carbon is stored.

A common misconception is that planted trees go on sequestering carbon forever, and therefore maintain an income stream from carbon credits for ever. This is not the case, and for traditional high density tree plantings (such as timber plantations or tree corridors) the maximum rate of carbon sequestration occurs quite early in the life of the stand (10 to 20 years). The site limit is quite quickly approached at around 50 years (see Figures 1 and 2).

After that time, very little income from carbon credits is available and the site has a carbon liability. This means the carbon must be maintained on the site for whatever time period designated in the carbon trading scheme.

In practice, under the current rules, this may mean a good income stream from carbon credits for the first 10 - 30 years, followed by limited income and a carbon liability over the land for a further 100 years. That is, the trees cannot be removed unless an equivalent amount of carbon credits are purchased in the marketplace to offset the removal.

This of course has quite significant land use consequences if the forest sink is densely planted and little, if any, agricultural production is available under the trees.

In this situation, little income can be generated once the site limit has been approached. Such densely planted forest sinks are best established on land:

- that has little, if any, alternative production value (e.g. sites with biodiversity conservation priority or land with little agricultural potential) and/or
- where the forest sink has the capacity to generate timber returns in addition to carbon credits (see page 5).

Figure 1. How carbon is expected to accumulate over time (green line) in a successfully established sugar gum plantation on red soil at Tamworth. (Modelled using FullCAM.)

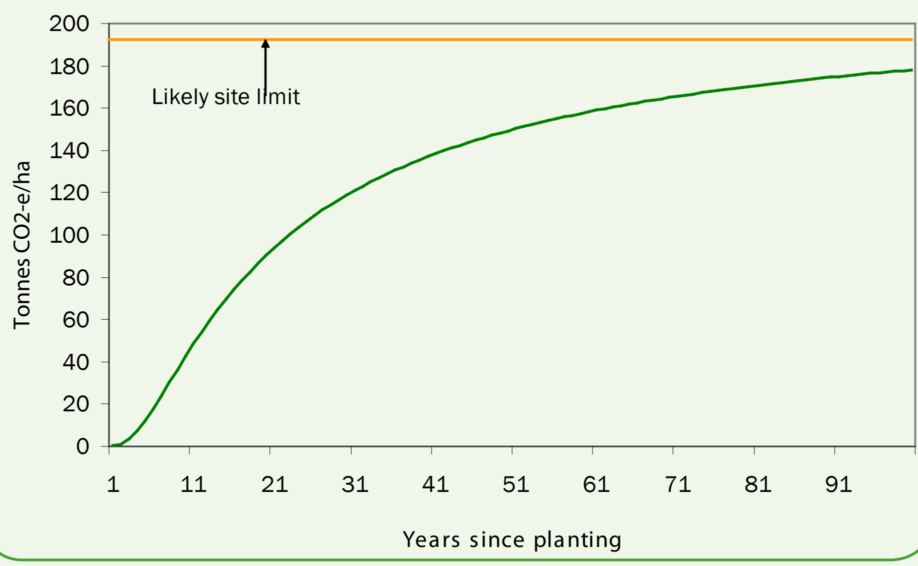


Figure 2. Expected gross annual carbon credit payments over time in a successfully established sugar gum plantation on red soil at Tamworth (modelled from FullCAM, assumes a carbon price of \$25/tonne of $CO_{2\text{-}e}$). Note - the returns are gross amounts and costs of an offset provider have not been factored in.

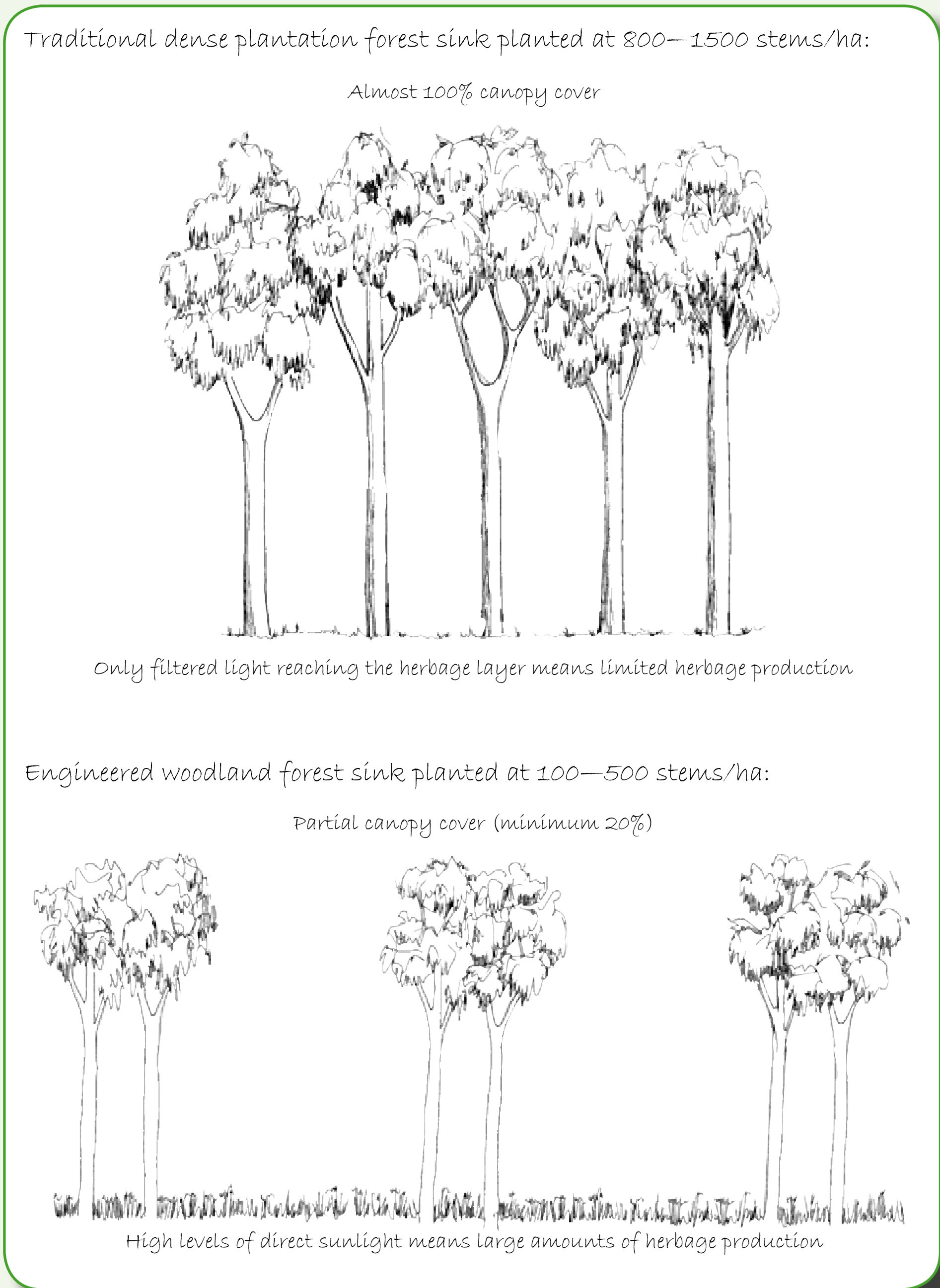


Figure 3. Diagrammatic representation of the amount of sunlight reaching the ground in a densely planted forest sink versus an engineered woodland forest sink.

Below: An Engineered Woodland near Kentucky. Photo by Michael Taylor.

Engineered woodland forest sinks

A significant advantage of engineered woodlands as forest sinks is that they allow flexibility of land use over the long term, effectively mitigating the problem discussed above.

As in denser forest sinks, after the trees have reached maturity and all carbon credits have been claimed, a carbon liability exists over the land. However, engineered woodlands provide large canopy gaps to allow sunlight to reach the ground and be available for pasture or crop production (see Figure 3). Therefore, agricultural land use can continue. Depending on the density of the trees, agricultural productivity may be slightly reduced due to tree competition with the herb layer. Alternatively, it may be enhanced by the shelter, shade, nutrient cycling and biodiversity benefits of having the trees in the system.

Information Sheet 2 provides more information on engineered woodland designs to suit various landscapes and land uses.

There are concerns among some regional communities that vast tracts of high-density tree plantations will displace agriculture in the landscape and, in the long term, reduce local populations and local economic activity. These concerns may be well-founded if high-density forests sinks are established solely for generating carbon credits.

However, forest sinks established in the form of engineered woodlands may be much more appealing for such communities as they maintain agricultural production and farmer populations, and therefore viable rural communities.

The disadvantages of engineered woodlands from a carbon sequestration point of view are:

1. the rate of carbon sequestration is lower in an engineered woodland than that available in a densely planted forest (see Figure 4)
2. the total amount of tree sequestered carbon may be lower at maturity compared to a high density forest, depending on the final canopy cover reached by the woodland
3. carbon trading organisations are at this stage accustomed to dealing with traditional high density plantations as forest sinks – particular organisations may require persuading to accept an engineered woodland as a forest sink for carbon trading purposes simply because they have not encountered such plantings before.

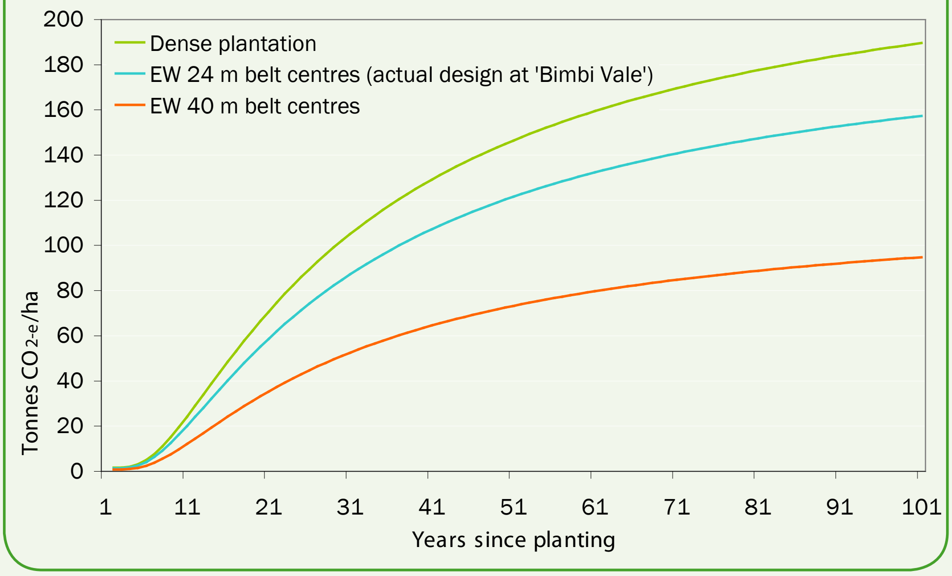
Importantly, the design of an engineered woodland as a forest sink must ensure that the planting density and arrangement of the trees complies with the eligibility rules of the relevant carbon trading scheme. The most important of these rules under Kyoto compliant schemes is the 20 per cent canopy cover rule. If the tree belts are planted too far apart, they may not reach this critical canopy cover level at maturity and will be ineligible as forest sinks. All of the demonstration plantings in the engineered woodlands project have been designed to achieve at least 30 per cent canopy cover with the most densely planted example expected to get close to 70 – 80 per cent canopy cover.

Combining carbon credit & timber income

Sustainable timber production is possible in any forest sink used for carbon storage, as long as:

1. not all of the potential carbon storage (i.e. up to the site limit) in the planting has been sold as carbon credits

Figure 4. Carbon accumulation at a site on 'Bimbi Vale' at Kentucky under three different planting densities. (Modelled using FullCAM.)



2. only part of a planting is harvested at any one time
3. only the amount of timber that is in excess of the carbon liability of the planting is removed at each harvest
4. the carbon trading scheme and the offset provider packaging and selling the carbon credits for the landholder allows harvest in a forest sink
5. all the rules of eligibility of the forest sink for the carbon trading scheme are maintained
6. harvested areas are replanted and allowed to re-grow to provide for each subsequent harvest.

For example, consider an engineered woodland on a site with the potential at maturity to sequester 160 t $CO_{2\text{-}e}$/ha in total. A possible scenario for management of the site may be:

- As the trees grow the landholder could choose to sell up to 60 t of $CO_{2\text{-}e}$/ha as carbon credits as they are sequestered. At this point the planting would have a carbon liability of 60 t $CO_{2\text{-}e}$/ha (and the landholder has pocketed the income) but it also has the potential to grow a further 100 tonnes/ha.
- The trees could be allowed to grow-on to the point where there is 85 t of $CO_{2\text{-}e}$/ha stored. The landholder could legitimately harvest timber from the site, up to the equivalent

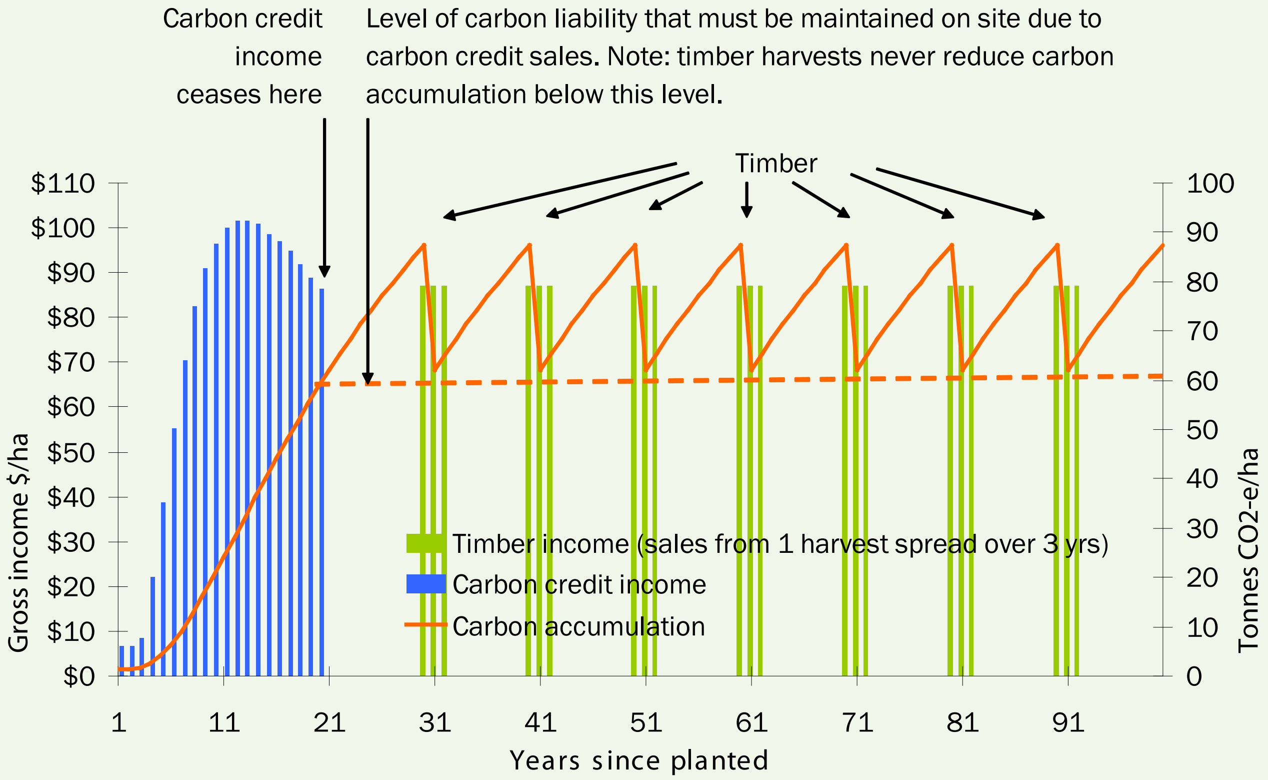
Carbon credits: sell or bank?

A landholder need not sell the carbon credits generated from a forest sink established on the farm. The landholder can retain ownership (bank them) and sell at some later date or use them to offset the farms own emissions if ever agriculture becomes a covered sector under the national CPRS.

Note, however, that the forest sink will still require registration with the appropriate carbon trading scheme and the carbon credits will need 'packaging' (see page 2) via the services of a carbon offset provider. Note also that only the carbon accumulated in the forest sink after the date of entry into the carbon trading scheme will be bankable or tradable.

Therefore, if you have a tree planting such as an engineered woodland that you intend using as a forest sink, it would be wise to register the planting early in its life to take advantage of all the carbon that it accumulates.

Figure 5. Expected carbon accumulation, gross carbon credit (@$25/tonne CO_{2-e}) and timber income over time at an engineered woodland on 'Bimbi Vale' Kentucky. (Modelled using FullCAM.)



**Timber income assumes harvest of only 25% of the available trees every 10 years from year 30.*
Also assumes 20% of each harvest = sawlogs @ $50/m3 and 30% = firewood @ $5/m3 with sales spread over 3 years post harvest.

of 25 t of CO_{2-e}/ha (i.e. ¼ of the trees or may be every 4th tree belt) and maintain their carbon credit liability (i.e. 60 t of CO_{2-e}/ha still remains in the planting after harvest). This could be done provided all the rules of the scheme are met e.g. 20 per cent canopy cover on average is maintained on the site.

- The trees could be replanted and once a further economic harvest level has grown back (say the equivalent of another 25 t of CO_{2-e}/ha), the next harvest could occur.
- Such periodic harvests could be sustained indefinitely and certainly for at least as long as the period of carbon liability.

Figure 5 illustrates the above example of combining carbon credit income and timber income using modelled data from a demonstration engineered woodland at Kentucky NSW.

Landholder's thoughts

As part of the Engineered Woodlands Project, each of the collaborating landholders were asked to consider using their plantings as carbon sinks and exploring the carbon market.

At the time Landcare Australia's CarbonSMART was the most accessible carbon pool management and brokering service available to ordinary landholders.

Each participant was provided with the opportunity to attend a detailed seminar on CarbonSMART and carbon trading. Considering that information, their own research, and the debate and developments nationally with the soon to be introduced CPRS, the following comments were made by the landholders:

"I think landholders who can establish relatively large forest sinks will have the most potential to benefit from carbon credits. We are small acre farmers and in our case the carbon in our engineered woodland will be of most value in enhancing the environment, including nutrient recycling, stock protection and in providing us with some renewable energy in the form of firewood."

Jim Reid, Arding

"I really can't accept the 100 year rule and I'm unlikely to consider carbon trading at this stage whilst such an impost on future generations exists."

Andrew Crawford, Woolbrook

"We don't discount becoming involved in carbon trading, however we will wait and see how things are clarified with the new [CPRS] legislation. Certainly the 100 year rule is unattractive to us. However, we may need forest sinks to offset our own emissions if agriculture becomes a covered sector."

Jim Hombsch, Duri

"I am wary of actually selling any carbon credits generated in our tree plantings. We may need all we can get to offset our own emissions in the future."

Sam White, Guyra

"We have just completed a life cycle analysis on livestock GHG emissions and our present carbon sequestering levels. The study was done by an independent expert using four years of data for our farm. In essence, the analysis suggests that to become 'carbon neutral' at our current stocking rates, we would need to have 47 per cent of the farm under some sort of tree canopy, either engineered woodlands or plantations! We have planted over 100,000 trees since 1990 and for the carbon audit to come up with this result looms as a dire warning for the many livestock farms that have nowhere near that amount of newly established trees. Unless soil carbon is able to be counted, and the methane cycle is better understood, agriculture needs to be left out of the CPRS altogether."

Jim Street, Wollun

"The 100 year rule and the relatively small annual returns involved means we are not likely to become carbon traders just yet. We are happy to establish our engineered woodland as a carbon sink for the good of the environment anyway. We may revisit the situation if agriculture becomes a covered sector in the national trading scheme."

Murray Nielsen, Tenterden

"We would consider trading in carbon credits from either tree- or soil-sequestered carbon, and we're particularly interested in the possibility of trading in soil carbon. I just need to fully understand the game first. I believe that the situation is a remarkable opportunity considering the huge natural resource management benefits that would occur as a by-product of sequestering more carbon in the landscape. This is also a great opportunity for the farming sector to become a catalyst for change in shifting human society towards real sustainability."

Gary McDouall, Bingara

Soil carbon

Currently carbon accumulated in a soil sink is not eligible for trading as carbon credits in accredited schemes in Australia.

The situation is under review, however, and at some future time there may be a market for any additional carbon that can be stored in soils on the farm.

In the meantime, soil carbon is intrinsically valuable for all measures of soil health and ecosystem resilience. Wherever possible, farm management should aim to increase the amount of carbon in the soil for its natural resource management and production benefits regardless of any potential value for carbon credits in the future.

Measuring carbon in a forest sink

To determine the amount of $CO_{2\text{-}e}$ stored in a tree planting at any time, we need to know the area of the planting (A), the volume of the trees per unit area (V) and the average wood density of the tree species present (D). Then, we know that approximately half of the dry weight of a plant is carbon, and that for every tonne of carbon there is approximately 3.67 tonnes of $CO_{2\text{-}e}$. The formula can therefore be expressed as:

$$\textbf{Tonnes } CO_{2\text{-}e} = A \times V \times D \times 0.5 \times 3.67$$

where A = area of land (ha); V = tree volume (m^3/ha); D = density (t/m^3).

In mature forests, the majority of the biomass is found in the wood (from tree trunk to fine branches). Calculating wood volume in a forest is straightforward and foresters have perfected simple methods to estimate this (see glossary for a simple technique for estimating the volume of a tree). Details of how to go about measuring trees and forests can be found in "Tree Manual for Farm Foresters" by Abed and Stephens (2003). Wood densities are also well known for at least the common species, and particularly timber species (see Table 1).

For much of the farmland of the Northern Tablelands and Northwest Slopes of NSW, forest sinks have the capacity to sequester carbon at 30 - 180 t/ha (110 - 660 t of $CO_{2\text{-}e}$) depending on site quality. Wetter, more fertile sites have the capacity to store more carbon than dry infertile sites.

For example, in a recent assessment of a mature manna gum woodland just east of Walcha on shallow trap soil, the author estimated that approximately 60 t/ha of carbon (220 tonnes $CO_{2\text{-}e}$/ha) was stored above ground.

Models

The accumulated knowledge of foresters and ecologists over the years, together with more recent targeted research facilitated by the Australian Greenhouse Office (AGO) means we now have quite a sophisticated and accurate model for estimating tree growth in forests, woodlands, and tree plantings over time.

The model, FullCAM, was developed by the AGO in collaboration with CSIRO and the Australian National University. FullCAM is now reliably used in the carbon accounting industry to predict the amount of carbon sequestration in forest sinks on any particular site. FullCAM and the National Carbon Accounting Toolbox is freely available to anyone via the AGO website www.greenhouse.gov.au.

Table 1. The wood density of common tree species of the Northern Inland of NSW (Source: Boland et al 1992, Forest Trees of Australia, CSIRO, Melbourne.)

Tree species	Approximate air dried wood density
Mugga ironbark	1170 kg/m^3
White box and yellow box	1100 kg/m^3
River red gum	880 kg/m^3
Manna gum	730 kg/m^3
Snow gum	690 kg/m^3
White cypress pine	680 kg/m^3
Radiata pine	530 kg/m^3

Glossary

Basal area: The area occupied by the base of a tree and is calculated by:

$$\text{Basal area (m}^2\text{)} = \pi \times \text{(circumference at the base of the tree} \div 2\pi)^2$$

Carbon credit: The colloquial name for a paper certificate that represents a unit of $CO_{2\text{-}e}$ (usually a tonne) that has been generated in a bona-fide carbon trading scheme. Carbon credits are more formally termed abatement certificates or emission permits. Each certificate issued in an accredited carbon trading scheme has a registered serial number and, where it has been created in a forest sink, the certificate is linked to the area of land on which the carbon is stored.

Carbon liability: Any area of land used as a forest sink and that has had carbon credits created and sold in a carbon trading scheme will have a carbon liability. The liability will be equivalent to the amount of carbon sold.

Crown cover: The area shaded by the vegetation (forest or individual tree) canopy when the sun is directly overhead.

Carbon Pollution Reduction Scheme (CPRS): The name proposed for Australia's national accredited carbon trading scheme due to operate from 2010.

Carbon sink: Any structure/process that removes CO_2 from the atmosphere and stores it where it does not contribute to the greenhouse effect. Carbon sinks can include vegetation, soil, oceans, geo-sequestration underground (proposed), and tree plantings (called forest sinks). However, under current rules, only forest sinks are allowed to be used for trading carbon credits in accredited schemes.

Forest rights agreement: Transfers the control of the carbon rights in a planting to the carbon offset provider, allowing carbon credits to be created and traded on behalf of the landholder. Note that ownership of the trees and the carbon remain with the landholder.

Greenhouse gases, $CO_{2\text{-}e}$: A number of gases contribute to the greenhouse effect including (in approximate order of importance): carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. The first three are the most significant, accounting for about 95 per cent of Australia's emissions. Each gas is rated in its warming effect relative to carbon dioxide and so emissions of each gas are reported in $CO_{2\text{-}e}$ (Carbon Dioxide Equivalents).

Restriction on use agreement: Currently used in the NSW GGAS where a legal agreement between the landholder and the State Government is put in place to ensure that the vegetation and the carbon in it stay on the site for the required period once carbon credits are sold. This agreement restricts current and all future landowners from clearing the vegetation required to meet any carbon credit liability. The agreement is registered on title. It is anticipated that a similar agreement will need to be used in the national CPRS when it is introduced.

Voluntary carbon market: This market operates outside government controlled and accredited carbon trading schemes (accredited carbon markets), i.e. they are currently unregulated. Voluntary schemes involve an offset provider selling a guarantee to a buyer that they will ensure either:

- a certain amount of greenhouse gases are removed from the atmosphere, or
- a permanent reduction in energy consumption that reduces emissions occurs (e.g. replacing incandescent light bulbs with energy efficient lighting).

High profile examples include Greenfleet and Elementree. Often trading involves the provider retailing offset products to small businesses and family consumers who wish to reduce their 'carbon footprint'.

The Australian Government will introduce a National Carbon Offset Standard to ensure the integrity of carbon offset products that consumers purchase. Presumably the National Carbon Offset Standard will be introduced with the CPRS.

Wood volume: A simple formula to estimate the volume of wood in a tree is the same as the formula used to calculate the volume of a cone:

$$\text{Volume (m}^3\text{)} = \text{basal area (m}^2\text{)} \times \text{tree height (m)} \times 1/3$$

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Further details of the engineered woodlands project can be found at *www.nio.com.au* (follow the forestry links) and *www.snelandcare.org.au*.

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Northern Inland Forestry Investment Group

Namoi CMA Catchment Management Authority

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