FARMING CARBON

BY SYD SHEA

For several decades trees have been planted in Western Australia for their timber and for their landcare benefits. The contribution of these tree plantings to reducing the quantity of carbon dioxide being accumulated in the atmosphere was always recognised, but the adoption of the Kyoto Protocol at the Climate Change Conference in December 1997 by many countries means that carbon sinks created by tree planting or vegetation rehabilitation could have a real commercial value. Western Australia is uniquely placed to contribute to the reduction in carbon dioxide concentrations by creating carbon sinks. This new product from commercial tree planting can assist rehabilitation of degraded farmland and rivers and estuaries suffering from eutrophication.

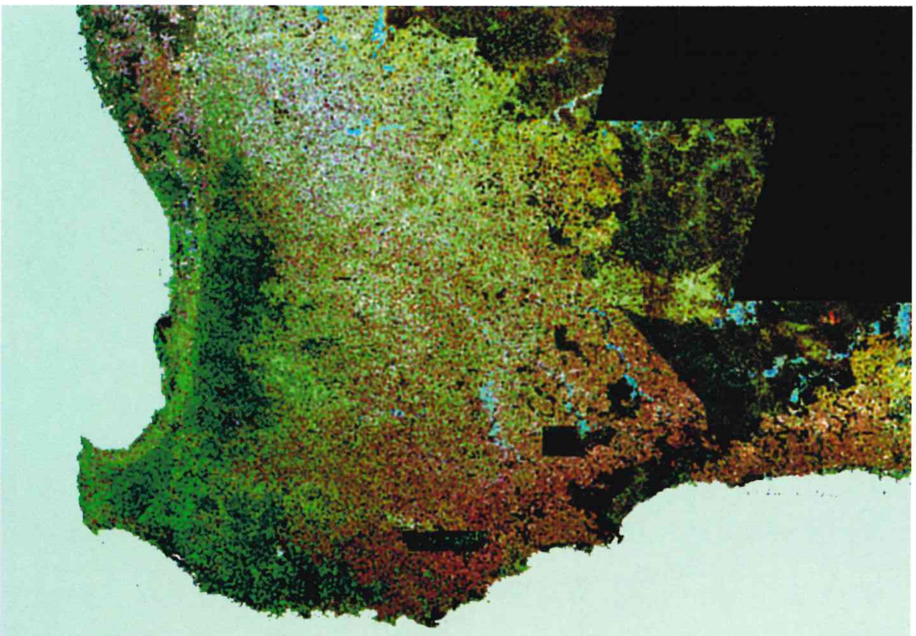
Greenhouse gases occur naturally and are part of our climate system. Water vapour, carbon dioxide, methane, nitrous oxide and others in the atmosphere absorb heat rising from the Earth's surface and then radiate some of that heat back towards the ground. Greenhouse gases have been increasing their concentration in the atmosphere because of human activities, such as burning fossil fuel and land clearing and there is a concern that this 'enhanced' greenhouse effect will result in global warming. The carbon dioxide (CO_2) concentration in the atmosphere is 30 per cent higher than it was 200 years ago.

Increasing concerns about the impact of rising concentrations of greenhouse gases on the world's climate, and the failure of nations to adopt, voluntarily, practices that would reduce emissions, led to an international agreement in Kyoto in December 1997 for developed countries to adopt legally binding greenhouse gas reduction targets. The so-called Kyoto Protocol requires developed countries to achieve a collective target of a five per cent reduction in emission from 1990 levels, by the 'first assessment period', which is 2008–2012. Australia was successful arguing that because of the nature of its economy its target should be eight per cent *greater* than its 1990 levels. Nations are required to show that they have made significant progress towards achieving their targets by the year 2005.

Nations that ratify the Protocol will be required to determine their net greenhouse gas emissions (emissions minus carbon dioxide absorbed to sinks like trees) in 2008 and 2012 in order to calculate their average annual net emission between those years. Australia's net emission level must not be more than eight per cent above its 1990 level. However, our national target cannot be quantified at this stage because the 1990 base year emissions have not been finalised. But if it is assumed that Australia's greenhouse gas emissions were the equivalent of 500 million tonnes of carbon dioxide, we will have to keep our increases in emissions below 40 million tonnes per year by the year 2012.

This will be a challenge because of the energy-intensive nature of our economy. For example, in 1995, Australia's emissions (excluding emissions caused by clearing vegetation) were already six per cent above the 1990 emissions. If proposed resource development projects in Western Australia proceed on schedule, their greenhouse gas emissions, using current technology, alone would probably exceed the eight per cent growth target allowed for the whole of Australia.

The Kyoto Protocol allows for carbon dioxide emissions to be offset by activities that absorb carbon dioxide. This means that nations can develop a national accounting system for carbon—the carbon 'balance' each year will be determined by the difference between the amount of carbon dioxide emitted and the amount absorbed into sinks. The Kyoto Protocol specifically recognises that activities such as afforestation absorb (or sequester) carbon dioxide. Thus, these activities can be used to create sinks and gain 'carbon credits'. This, together with the articles in the protocol that provide for



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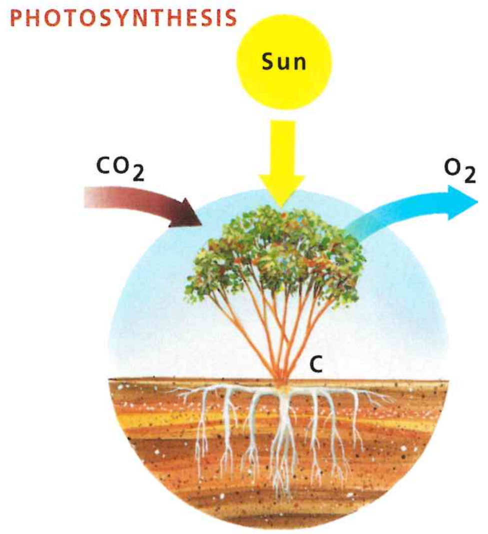
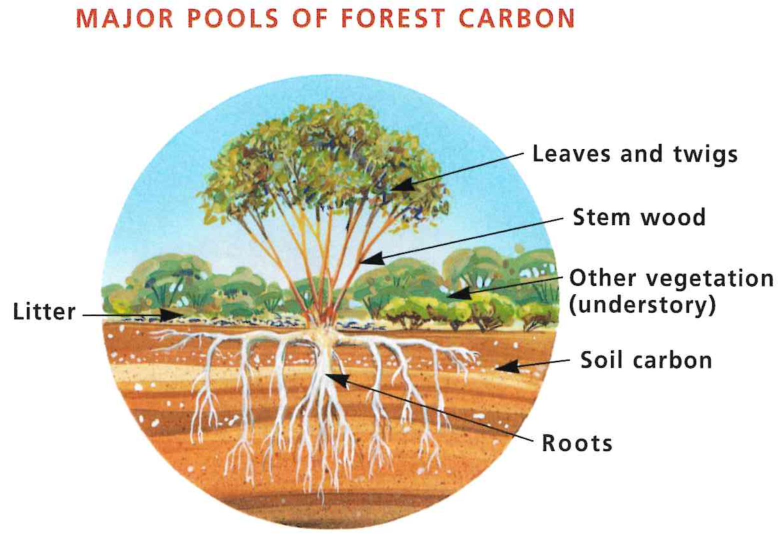
The amount of carbon sequestered in a tree is related to the dry weight of the whole tree. This means measuring not just the timber, but also the roots, branches and leaves.
Photo – Gary Hartnett

Above: Rows of maritime pine—more than half-a-million hectares have been assessed as suitable for this tree crop.
Photo – Michael James/CALM

Left: Satellite images of Western Australia's south-west land division show just how much land has been cleared for agriculture. It is estimated that more than three million hectares are potentially available for tree crops and landcare plantings.





trading of carbon emissions and carbon credits, has focused attention on the use of tree crops and vegetation rehabilitation as a means to offset some of the carbon emissions. While the carbon accounting rules are still being finalised, it is likely that sequestered carbon will have a commercial value. Despite the absence of rules there are already 'carbon markets'. Australia, and particularly Western Australia, has a significant disadvantage in achieving the Kyoto targets because of the energy-intensive nature of our economy. But we do have one significant advantage—our capacity to sequester large quantities of carbon by tree planting and vegetation rehabilitation.

Below: Soil has been dug away to expose the extensive root system of this pine.
Photo – Syd Shea

Below right: Oil mallees, which are being planted on farms in the 250–400mm rainfall zone, are not yet a commercial crop. The carbon stored in their woody roots could increase their value and make it possible to plant many more trees.
Photo – Chris Garnett/CALM

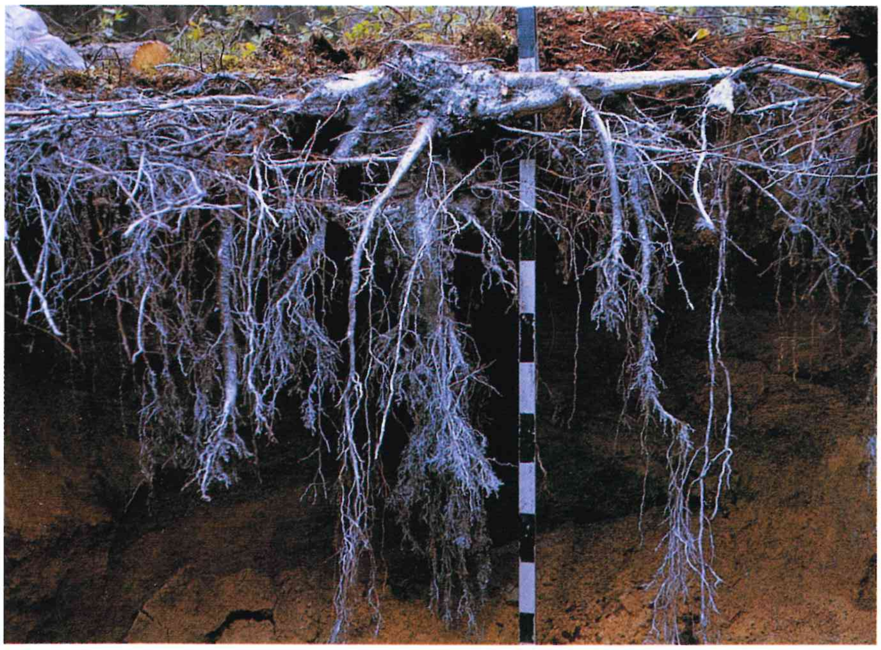
CARBON SINKS

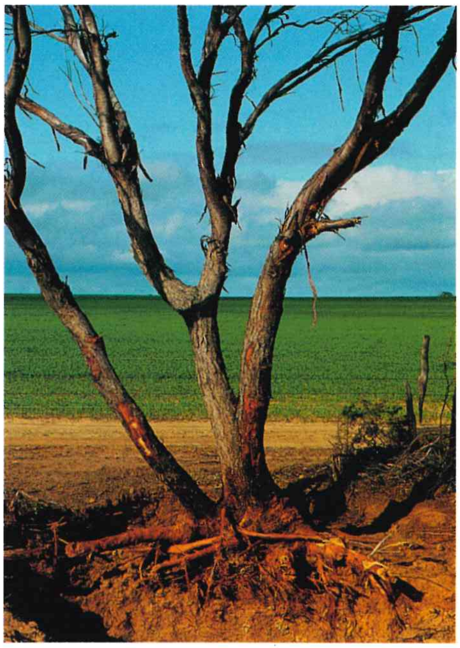
Plants use energy from the sun to convert carbon dioxide and water into simple sugars by the process called photosynthesis. In trees these are converted into the complex carbon molecules that constitute wood. One molecule of CO_2 contains 27 per cent carbon so that for every tonne of carbon that is produced by plants 3.7 tonnes of carbon dioxide are extracted from the atmosphere.

The world's forests already constitute a major carbon sink. Deforestation is one of the reasons why carbon dioxide concentrations have increased in the atmosphere. Theoretically, it would be possible to consume the extra carbon dioxide that is being emitted into the atmosphere by expanding forests or tree plantations. However, it has been calculated that up to 500 million hectares of new forests would be needed to sequester the 20–25 billion tonnes of carbon dioxide that is released world-wide through the burning of fossil fuels and deforestation. This is about five times the world's current area of commercial tree plantations.

Above: Fueled by energy from the sun, plants take in carbon dioxide from the atmosphere and extract the carbon to make sugars. The remaining oxygen molecules are released.

One of the criticisms of using trees to

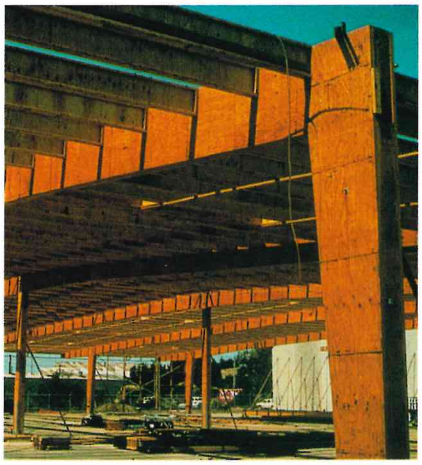




offset carbon dioxide emissions is that the effect is only temporary—even if the trees are not harvested, they eventually die and decompose, returning the sequestered carbon back into the atmosphere. If tree crops or landcare plantings are maintained by replanting, the carbon pool will continue to be maintained, although the rate of increase in the carbon pool will lessen. Many scientists argue that given the uncertainty surrounding greenhouse science, 'buying time' by sequestering carbon in tree crops would allow time to develop new or more efficient technologies, such as alternative energy sources.

Tree crop products could permanently contribute to reductions of carbon dioxide concentrations in the atmosphere if they were used to generate energy, replacing fossil fuels, and to replace products that take a lot of energy to produce. For example, replacing steel, aluminium and cement with wood products would result in a direct reduction in greenhouse gas emissions.

Recently, more attention has been given to determining the effect of sequestering carbon for different lengths of time on global warming. The Intergovernmental Panel on Climate Change (IPCC)—the international group of expert greenhouse scientists who advise the international community on greenhouse issues—agrees that a proportion of the molecules emitted into the atmosphere have a finite life. Eventually, a proportion of the CO_2 molecules emitted are absorbed into sediments in the deep oceans. The effect of offsetting the carbon dioxide emitted for varying periods of time on potential global warming, at this stage of the development of greenhouse science, cannot be quantified. Even if carbon stored in trees is eventually re-emitted to the atmosphere, in addition to 'buying time' it will reduce the ultimate global warming by an industrial emission. The longer a tonne of carbon is locked up in woody tissue, the greater the benefit.



HOW MUCH CARBON CAN TREES SEQUESTER?

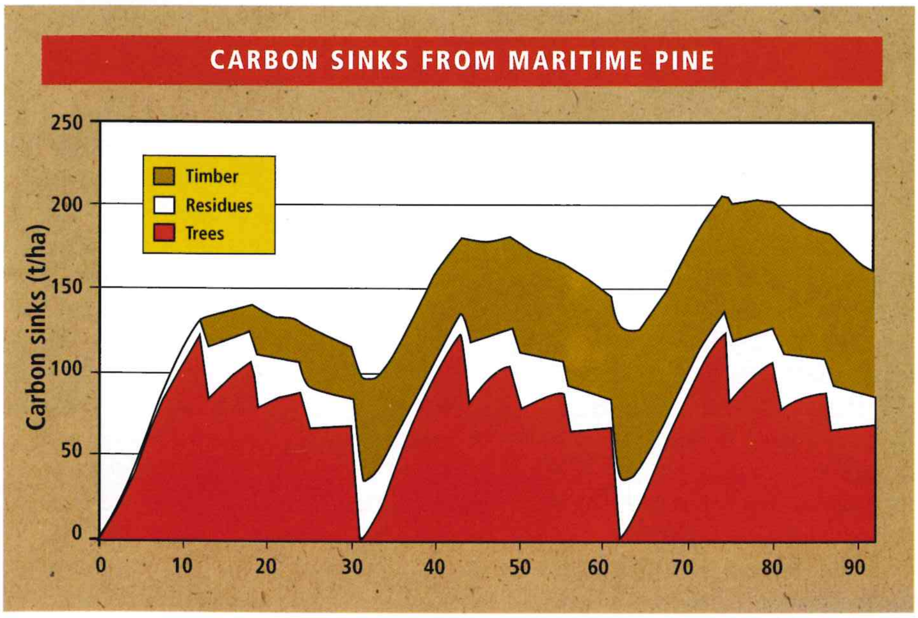
One of the advantages of farming carbon is that the total biomass of the tree counts, not just the part that is suitable for timber production—in other words, the trunk, roots, branches, leaves, etc. Total biomass can be relatively easily measured for various tree species at different ages of development. This involves dissecting whole trees and weighing each of the other components—roots, leaves, branches—and determining their dry weight. It is possible to establish a relationship between easily measured tree parameters, like height and diameter, and tree biomass. The amount of carbon fixed in woody tissues is equivalent to approximately half the dry weight of the biomass.

The amount of biomass produced varies according to the tree's age—trees grow slowly at first, pass through a stage of rapid growth and then growth plateaus until it almost ceases. Eventually, the amount of carbon fixed by a forest or a plantation equals the amount of carbon released by decay and respiration.

The average amount of carbon fixed per year can be calculated by measuring the total biomass which has accumulated on a hectare and dividing by the rotation age. Another method is to estimate the average growth each year and adjust it for any material lost over the rotation

CARBON RELEASED AND STORED AND FOSSIL FUEL ENERGY USED IN THE MANUFACTURE OF BUILDING MATERIALS

Material	Carbon released (kg/t)	Carbon released (kg/m³)	Carbon stored (kg/m³)	Fossil fuel energy (MJ/kg)	Fossil fuel energy (MJ/m³)
Rough sawn timber	30	15	250	1.5	750
Steel	700	5 320	0	3.5	266 000
Concrete	50	120	0	2	4 800
Aluminium	8 700	22 000	0	435	1 100 000



Top: New timber products, such as laminated veneer lumber, have great structural strength, making it possible to replace materials that release much more carbon into the atmosphere.
Photo – Kevin Lyngcoln

Above left: This table shows the huge variation in the amount of carbon released by different building materials. Timber is the only product that *stores* carbon.

Left: This graph (based on a model developed by Peter Ritson) shows predictions of carbon sinks obtained from maritime pine on one hectare which is thinned at 12, 18 and 24 years and harvested and replanted every 30 years.

More than 120,000 hectares of tree crops have already been established on farmland in the State's south-west. Like the bluegums shown here, tree crops can be integrated with traditional agriculture and located to help protect native vegetation and reduce salination.
Photo – Jiri Lochman

because of natural mortality or harvesting. Currently, the preliminary carbon accounting rules do not recognise the carbon stored in the timber products that are produced when the trees are harvested, but we are examining whether this can be changed. The carbon contained in wood products that are used for buildings or furniture may be stored for decades after the trees are harvested. One way to maximise the amount of carbon fixed on a hectare of land is to ensure harvesting occurs before tree growth declines and to convert the timber harvested to products with long lives, such as structural timber or board products. Determining how long carbon is fixed in a stand of trees is more complex, but reasonable estimates can be made of the length of time that different carbon pools (including the carbon lives of timber products made from the tree stem) of a tree remain fixed. Thus, it is possible to calculate the tonnes of carbon that are fixed per year per hectare and the average number of years that carbon remains fixed. Consequently, it is possible to estimate the number of 'tonne years' of carbon that a tree crop or other types of perennial vegetation produced each year, or the total amount of carbon stored in trees or other types of vegetation over a specified period.

In Western Australia, there is extensive data on the growth rates of the major tree species being established on farmland and in plantations. Studies are being undertaken to calibrate these measurements with total biomass production. Preliminary studies have been carried out to determine the biomass production of mallee eucalypts that are being planted in the Wheatbelt for landcare and for their potential to produce eucalyptus oil. Rehabilitating pastoral land degraded by grazing pressure from domestic and feral animals can also result in significant sequestration of carbon.

LAND AVAILABILITY

One of the principal constraints on using trees to offset carbon dioxide emissions around the world is the availability of suitable land. Apart from consideration of price and productivity, the land must be secure—carbon sequestration, to be effective, must be long term—and extensive tree planting must be politically and socially acceptable. Western Australia is uniquely placed to meet these criteria because it has a large land base suitable for growing trees, legal procedures to secure land, and a large area of tree crops has already been established on farmland in partnership with farmers.

The area of south-west agricultural land potentially available for tree crops and landcare planting could total more than three million hectares (out of a total area of 18 million hectares). In addition, about 10 per cent, or five million hectares, of pastoral or rangelands could be available to sequester carbon.

In the 1980s, CALM developed the 'tree crop sharefarming' scheme in association with the Western Australian Farmers Federation. Under this scheme, using a specifically designed legal contract—'profit a prendre'. Under the sharefarming agreement, a landowner can allow the use of his land for commercial tree crops, without foregoing his title to the land. The investor in the tree crop venture has secure rights to access the crop, and a sharefarming agreement is registered on the land title, which ensures security is maintained even if the property is sold. The agreement provides for the commercial returns to be shared between the investor and the landowner.

LAND AVAILABILITY AND TOTAL CARBON SEQUESTERED OVER A 30-YEAR PERIOD

Rainfall zone	Tree crop zone (mm)	Gross area (million ha)	Potential for revegetation	Projected planting area (ha)	Average carbon sequestered (tonnes/ha)	Total carbon tonnes sequestered over 30 years
> 600	Maritime pine		30%	100 000	103*	10 300 000
	Bluegum	2		250 000	49	12 250 000
	Landcare species			250 000	54	13 500 000
400-600	Maritime pine	6	25%	500 000	103*	51 500 000
	Landcare species			1 000 000	40	40 000 000
250-400	Mallee eucalypts	10	10%	500 000	31	15 500 000
	Landcare species			500 000	27	13 500 000
< 250	Pastoral regeneration	85	10%	8 500 000	5	42 500 000

* Assumes credit for carbon contained in timber products

Above: Rising salinity levels threaten nature conservation as well as farmland. Without urgent action, half of the region's conservation reserves will be lost including the last three remaining freshwater wetland systems.
Photo – Kim Howe

Left: This table indicates the gross size of carbon sinks potentially available in Western Australia.

CALM has established more than 1,000 joint ventures with farmers to establish tree crops on privately-owned land since 1987. More than 120,000 hectares of tree crops have been established on farmland in Western Australia since 1986 by CALM and private companies.

INTEGRATING CARBON FARMING WITH LANDCARE CONSERVATION AND TIMBER PRODUCTION

It is impossible to determine what the returns from farming carbon will be because, currently, there is no official market price for a tonne of carbon. However, some analysts predict that it could be in the range of $5–$40 per tonne. The cost of fixing a tonne of carbon, including land costs, varies between zero (for some commercial tree crops) and $50. Payment for carbon credits could increase the rate of return on a tree crop by up to five per cent.

Western Australia's Salinity Action Plan, launched by the State Government in 1996, estimates that an extra three million hectares of trees and perennial shrubs will have to be established in the agricultural zone (along with other measures) to control salination at a cost of $3 billion.

Farming for carbon credits is yet another incentive for landowners and investors to plant trees and protect native vegetation. Western Australia already has a rapidly growing program of tree crops and landcare planting on farms, spurred on by concerns about land degradation and a rising demand for timber products (see 'Tree Crops for Farms', *LANDSCOPE*, Summer 1992–93 and 'Halt the Salt', *LANDSCOPE*, Spring 1997).

Another commercial product from tree crops, in the form of carbon credits, will make tree planting more rewarding and land rehabilitation more attainable. Potentially, tree planting and vegetation rehabilitation in the agricultural and pastoral areas of the State could sequester more than 200 million tonnes of carbon over a 30-year period, a significant contribution towards reducing the global warming potential of greenhouse gasses and a major contribution towards achieving Australia's greenhouse gas targets.

Dr Syd Shea is CALM's Executive Director. He can be contacted on (08) 9442 0325.

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DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Executive Editor: Ron Kawalilak. Managing Editor: Ray Bailey. Editor: David Gough. Story Editor: Caris Bailey. Designer: Maria Duthie