BY **GRAEME JENNINGS**
JON LAMB COMMUNICATIONS

# More to carbon than sequestration

Higher soil carbon levels bring significant biological benefits, whether or not payment for carbon sequestration is available.

Concern about climate change has focused attention on 'carbon trading' and long-term carbon sequestration as a means of reducing the role of carbon dioxide ($CO_2$) in global warming.

With carbon a major part of the biological systems on which farmers depend, it has been suggested that carbon sequestration may provide growers with an additional source of income.

The ability to sequester, or 'tie up', carbon is influenced by climate and the production system, so there is no guarantee growers, particularly in low-rainfall regions, will be able to ensure long-term storage of additional carbon in their farming systems.

According to soil ecologist Dr Christine Jones, effective carbon management is the key factor for productive farms, revitalised catchments and a greener planet.

"Organic carbon such as humus has many benefits in soils, including the ability to trap and store moisture.

"A 1 pc increase in humus in the top 30 cm of a soil with a bulk density of 1.2 g/cm$^3$ will increase the waterholding capacity of that soil by more than 14 litres of water a square metre – 1.4 megalitres over 10 ha."

This is in addition to increases in water-holding capacity resulting from the improved soil structure of higher-carbon soils.

"The flip side is that the same amount of waterholding capacity will be lost when soil carbon levels fall," she says.

"Re-balancing the soil water equation and re-balancing the greenhouse equation both require soil building, which in turn requires that $CO_2$ from the atmosphere be sequestered in soil as organic carbon."

Dr Jones, founder and CEO of Carbon For Life, which has developed the Australian Soil Carbon Accreditation Scheme (ASCAS), is using the scheme as a promotional springboard for 'soil building', a concept promoted by proponents of Permaculture, organics and more recently biological farming.

James Bee, an agronomist with Great Northern Rural, taking soil samples that will be used to benchmark soil carbon levels for the NACC/ASCAS Soil Carbon Initiative in Western Australia. The process will be repeated in 12 months' time to check whether carbon levels have incresed or decreased.

'Soil building', which occurs when some of the carbon sequestered from the atmosphere by green plants combines with weathered mineral particles in the soil to form new topsoil, requires that more carbon be stored in soil than is lost to the atmosphere, she says.

"The world's soils hold three times as much carbon as the atmosphere and more than four times as much carbon as the vegetation, so soil represents

the largest carbon sink over which we have control. And groundcover management is the prime determinant of whether agricultural soils release or take in atmospheric carbon.

"Healthy grasslands may contain over 100 times more carbon in the soil than on it, making a well-managed perennial grass ley the quickest and most effective way to restore degraded land."

However, any farming practice that improves soil structure is building soil carbon and on-farm water, energy, life, nutrients and profit will increase as soil organic carbon levels rise, she says.

Atmospheric carbon translocated to the soil as organic carbon helps build organic matter.

Dr Jones has no doubt that, with changes to management regimes, significantly more carbon can be stored in our soils than they currently hold.

"Carbon cannot be sequestered in soils if we continue with the same forms of land management that caused the carbon losses in the first place," she says.

"Living plants provide the most important form of groundcover for carbon sequestration because they are the conduit between the atmosphere and the soil and provide the 'way in' for soil carbon. $CO_2$ drawn from the atmosphere through the process of photosynthesis in green leaves is transformed into carbon compounds, many of which are exuded into soil from actively growing roots.

"This is why it is important to have a large volume of fibrous roots in soil at all times of the year – even in cropping enterprises.

"The carbon compounds added to soil as exudates from active plant roots and the decomposition of plant and animal residues fuel the biological processes that improve soil structure, increasing oxygen and moisture retention in the soil and creating better conditions for more life.

"Soils under healthy perennial pasture may contain up to 350 tonnes of carbon a hectare and sustain high levels of microbial activity. These conditions provide an excellent base for an annual crop, provided the perennial root biomass remains."

While it seems doubtful Dr Jones' ideal of perennial green cover is achievable in low-rainfall areas such as the Mallee or Wimmera, there is work underway on low-rainfall systems that may open the way for higher soil carbon levels.

This work, which is in only its early stages, is strongly influenced by the concepts promoted world-wide by South American consultant and no-till advocate Rolf Derpsch.

Dr Derpsch, like Dr Jones, is an advocate of full soil cover year round, but accepts that, during at least some of the year, that cover will be provided by a thick mulch of dead vegetation, which he advocates be rolled into the soil surface using a knife roller.

Such a mat of mulch requires that crops sown into it be established with disc

## Soil carbon trading trial

A fledgling soil carbon trading scheme is being trialled in WA.

Under Australia's first soil carbon trading scheme, the Australian Soil Carbon Accreditation Scheme (ASCAS) will accredit carbon sequestered (stored) in a variety of farm soils and sell the amount of carbon stored to polluters as carbon credits.

One 'Carbon Credit' – referred to by ASCAS as a 'Soil Restoration Credit' – contains the same amount of carbon as one tonne of carbon dioxide ($CO_2$). This equates to 3.67 tonnes of carbon.

The scheme is being trialled in conjunction with the Northern Agricultural Catchments Council (NACC) and the WA Department of Agriculture and Food and is focused on areas being converted from an annual cropping system to perennial pastures.

The 'proof of concept' pilot is being conducted on 12 properties in the NACC area, in districts with average annual rainfalls of less than 350 mm, 350 to 450 mm and more than 450 mm and a variety of soil types.

The 12 participants were selected from 44 landholders who applied to participate. Each landholder has had approximately 20 hectares of land identified as a defined sequestration area – a potential source of Soil Restoration Credits that will be purchased by Carbon For Life Inc at a price of $25/t of CO2 equivalent – approximately 270 kg of carbon.

Every 2.7 tonnes of carbon sequestered in the soil is equivalent to taking 10 tonnes of $CO_2$ out of the atmosphere.

Jane Bradley, NACC's Incentives Program Manager, says the initial objective is to determine how much carbon can be added to soil under different field conditions, and since the available data suggests carbon build up is likely to be greatest under permanent pasture, all the land in the pilot program is cropping land newly converted to perennial pasture.

NACC has sampled the soils in each of the defined sequestration areas – at four depths to 110 centimetres – and will calculate the total soil carbon stock in tonnes a hectare using soil bulk density and soil carbon concentrations.

Two analyses – Walkley Black organic carbon and total carbon – are being carried out on by a NATA accredited laboratory on the 240 samples taken during the first round of sampling.

This process will be repeated annually and the gain (or loss) in carbon calculated. During the pilot phase of the program there will be no penalty if carbon levels decline, Ms Bradley says.

Sequestered carbon needs to be 'tied up' for extended periods – 70 to 100 years in many of the carbon trading structures being developed around the world. ASCAS will pay landholders 1 pc of the value of each 'credit' – 25 cents under the pilot arrangements – at the end of each year for validated soil carbon increases.

According to Dr Christine Jones, founder and CEO of Carbon For Life, which has developed ASCAS, the $1.3m pilot project will establish a 'validated soil carbon trading model' and 'create a collaborative and progressive market-based instrument to help address a wide range of environmental issues'.

seeders rather than the tined implements that tend to be standard in southern Australia and limits the potential for use of soil-activated herbicides such as trifluralin.

Dr Jones favours green cover because green plants use atmospheric carbon and translocate it to the soil as organic carbon, which builds organic matter and develops optimum physical and biological conditions in the soil, irrespective of agricultural enterprise, environment or landscape position, she says.

"The cheapest, most efficient and most beneficial form of organic carbon for soil is exudation from the actively growing roots of plants in the grass family, which includes many crop plants.

"Decomposition of fibrous roots is also an important source of carbon in soils.

"Organic carbon additions are governed by the volume of plant roots per unit of soil and their rate of growth. The more active, fibrous plant roots there are, the more carbon is added.

"It's as simple as that."

Dr Derpsch maintains that 'farmers who have not understood the importance of an adequate mulch cover have not yet understood the [no-till] system'.

He advocates 'at least six and if possible more than 10 tonnes of dry matter from green manure cover crops and cash crops per hectare per year', which he says provides good weed suppression, positive effects on soil moisture and soil temperature and improved chemical, physical and biological soil fertility.

The SA No-till Farmers Association (SANTFA) and the WA No-tillage Farmers Association (WANTFA) both have GRDC funding to explore aspects of this 'permanent mulch' system, a concept Dr Derpsch belives has the potential to take no-till to 'a new level' in Australia.

WANTFA Scientific Officer Ken Flower says much of the current work in WA, where there is a variety of pasture legume options available, is focused on what

Dr Christine Jones: re-balancing the soil water equation and re-balancing the greenhouse equation both require soil building.

plants might work as groundcovers or as mulched green manures and how they might be managed.

So far as carbon sequestration is concerned there was a greater chance of significant sequestration where there was more rainfall, he says, and growers in WA concerned about sequestration were exploring the options offered by pasture and oil mallees.

SANTFA Research and Development Manager Greg Butler is exploring the potential for sowing cover crop in the inter-row space of grain crops, but this work is in only its second year and was affected by drought last season, when it was clear the cover crop competed with the grain crop for the limited moisture available.

This observation highlights a key concern for growers in southern cropping areas: will cover crops reduce the amount of water available for grain crops?

NSW consultant Alan Umbers questions whether it is possible to increase soil carbon levels to 3 pc or greater – as is often suggested – in low-rainfall southern regions, given that much of Australia's remnant 'virgin' soil in southern cropping areas contains much less than that.

Modern cropping practices may increase soil carbon, but scientific evidence suggests any build up is likely to be slow and improving and maintaining higher soil carbon levels would require dramatic alterations to cropping and grazing systems, he told growers at several recent GRDC Research updates.

The Derpsch 'permanent groundcover' model would appear to fall into the category of 'dramatic alteration'.

Mr Umbers, who is managing the grain industry's Australian Sustainable Farming Practices Database Project, suggests growers considering the 'carbon market' proceed cautiously and pay close attention to any contract they are offered, since the amount of fossil fuels and fertiliser used by grain growers means they are generally net emitters of greenhouse gases.

The database project aims to gather information from growers about their farming practices and is currently developing a Greenhouse Gas emission indicator for inclusion in the personalised farming reports provided to growers

## Rewards for improving soil

Farmers in Canada, North America, Mexico and Brazil have been trading soil carbon since April 2005 and it is 'time for Australian farmers to be rewarded for improving their soils', according to Christine Jones.

Dr Jones, founder and CEO of Carbon For Life, is using the carrot of income from carbon trading to focus attention on the importance of improving carbon levels in Australian soils, which carries benefits far beyond income from carbon trading.

"Organic carbon has many benefits in soils, making effective carbon management the key factor for productive farms, revitalised catchments and a greener planet," says Dr Jones.

Dr Jones, a groundcover and soils ecologist who gained her degree and doctorate in NSW, believes soil carbon sequestration can be relatively rapid under 'regenerative management regimes'.

who supply data for the project. See the web site: www.farmingpractices.com.au.

"Any future carbon trading scheme will take into account emissions and sequestration when calculating soil carbon changes, and if you look at all the elements in the farming systems used in the Australian Grains Industry, most systems will have a net emission rather than any significant sequestration," Mr Umbers says.

"A farmer emitting greenhouse gasses by virtue of their fuel and fertiliser use could end up paying a bill instead of receiving a payment and any participation in carbon trading will require verification and auditing, which involves cost.

"The reality is that the grains industry is a net emitter of greenhouse gasses, to the tune of approximately 400 kg/ha of $CO_2$ equivalent a year."

And this is after having reduced emissions by approximately 500,000 tonnes of $CO_2$ a year over the past 15 years as a result of adopting minimum and no-till farming systems.

When it comes to carbon build up in farming soils, research suggests southern Australian grain growers, no matter how conservative their tillage and fertiliser practices, will struggle to add much more than 100-200kg/ha of carbon to soil a year, Mr Umbers says.

Calculations using SOCRATES, one of several models developed to estimate the carbon impact of Australia's cropping industries, suggest that typical southern crop rotations and inputs can improve soil carbon levels at around 0.01 pc a year – around 100 kg/ha a year – for 10-20 years, after which the carbon level plateaus at a new equilibrium point slightly higher than that in native soil under natural vegetation.

If 100kg/ha of carbon is able to be sequestered each year the total impact would be 2 million tonnes over the 20 million hectares of crop grown in Australia, he says, but maintaining these gains is likely to be a challenge, since carbon cycles in and out of the soil.

Dr Jones agrees that 'adding organic carbon to soil is one thing; keeping it there is another' but hastens to point out that any net increase in organic carbon in soils is a win-win for plants, animals and people.

And she believes appropriately managed soils have an enormous capacity to sequester atmospheric carbon, pointing to carbon gains of 20t/ha/year by landholders in the northern agricultural region of WA who are 'planting perennial grasses into formerly annual-based systems'.

Several growers in central NSW are reported to be successfully growing winter cereals sown into hard-grazed summer pastures based on native grass species; a technique dubbed 'pasture cropping'.

Despite the apparent 'northern' focus of these initiatives, Dr Jones suggests the potential for soil carbon sequestration in cooler regions such as south-east SA and south-west Victoria is higher than in many parts of Queensland or northern WA because carbon accumulation is more rapid in cooler climates.

"Carbon equilibrium levels in soil are determined by carbon inputs and outputs, which are influenced by temperature, rainfall and management.

"In general terms, soil carbon accumulation is positively correlated with rainfall and negatively correlated with temperature, so more carbon can be stored in soil in cold, moist environments than in hot, dry ones.

"Landholders can't alter rainfall or ambient temperature regimes, but they can markedly improve water infiltration rates, soil moisture retention, the buffering of soil temperatures and carbon inputs and outputs, through changes in groundcover management."

Mr Umbers is concerned that growers in Australia's low-rainfall cropping areas not base their carbon sequestration expectations on what happens in soils and climates in other regions, especially overseas, but is still keen to see farmers aim for higher carbon levels.

"Adding carbon to soils assists with water holding, nutrient availability and soil structure, all of which have benefits for plant growth and production, so more carbon in soils will assist with growing better crops, irrespective of the sequestration issue.

"But it can be unrealistic to equate what happens in soils and climates in some regions, especially overseas, with what is feasible in the low rainfall cropping areas," he says.

"More carbon can be added to soil in high rainfall, cooler areas where perennial pastures are a feature than in low-rainfall annual cropping systems." ■

**More information:**
**www.amazingcarbon.com;**
**Alan Umbers, (02) 6273 3000;**
**alan@grainscouncil.com**