Australian Soil Carbon Accreditation Scheme (ASCAS)

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Abstract

Appropriately managed agricultural soils can sequester large volumes of atmospheric carbon dioxide, significantly improving soil water-holding capacity, nutrient status and agricultural productivity.

Under the Australian Soil Carbon Accreditation Scheme (ASCAS), carbon sequestration is measured within Defined Sequestration Areas (DSAs) located on regeneratively managed broadacre cropping and grazing lands. Soil Carbon Incentive Payments (SCIPs) are paid annually and retrospectively for validated soil carbon increases above initial baseline levels determined within each DSA.

Receipt of Soil Carbon Incentive Payments is similar to being paid 'on delivery' for livestock or grain, with the bonus being that sequestered carbon remains in soil, conferring production and NRM benefits. Soil Carbon Incentive Payments are calculated at one-hundredth the 100-year rate ($25/tonne CO2-e).

The ASCAS model is based on financial reward from the private sector, creating a collaborative and progressive market based instrument to help address a wide range of environmental issues. Increased levels of soil carbon have multiple landscape health and productivity advantages.

The Australian Soil Carbon Accreditation Scheme is a first in the Southern Hemisphere, placing Australia among world leaders in the recognition of soils as a verifiable carbon sink.

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Introduction

Despite beliefs to the contrary, SOIL IS A RENEWABLE RESOURCE. 'Growing new soil' is very much like 'growing a tree'. Both processes require green leaves, carbon dioxide, water and light to fuel the production of photosynthetic materials. In trees, some of the carbon sequestered from the atmosphere by green leaves combines with other elements to form new wood. Beneath green groundcover, some of the carbon sequestered from the atmosphere and channelled into soil via roots and mycorrhizal fungi, combines with weathered mineral particles to form humus and new topsoil. Soil biota are an essential part of this equation.

The processes that build new topsoil require that more carbon be stored in soil than is lost to the atmosphere. Organically rich topsoils, high in humic materials, were present in many parts of Australia at the time of European settlement, particularly in the grasslands and grassy woodlands which once covered vast tracts of the continent. Even in arid areas, soils originally contained more humified organic matter than is often assumed and certainly far more than they do today.

The most significant cause of carbon depletion over the last 150 years has been the loss of topsoil through wind and water erosion, due to inappropriate groundcover management.

The carbon cycle

All living things are part of the carbon cycle. Carbon atoms are continually turned over during the natural progression through birth, growth, death and decay. Carbon is always in a state of flux, moving between plants, animals, soils, microbial biomass, the atmosphere, rivers and oceans. Some of the carbon atoms in our bodies at this moment would have been constituents of the plants, animals and soils present on earth many millions of years ago. People are around 18% carbon, wood around 50% and the organic matter component of soils is around 58% carbon.

In a healthy ecosystem, vibrant, living soils are a dynamic part of the carbon cycle. 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, which in turn increases oxygen and moisture retention and creates better conditions for more life.

When people think ‘carbon’ they usually think ‘trees’, but in reality 82% of carbon in the terrestrial biosphere is in the soil. 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.

What is a carbon sink?
When carbon dioxide is removed from the atmosphere and stored in the biosphere as either organic or inorganic carbon it is said to be **sequestered**. Places where carbon is stored are called **carbon sinks**.

The world's soils hold three times as much carbon as the atmosphere and over four times as much carbon as the vegetation. Soil therefore represents the largest carbon sink over which we have control. Groundcover management is the prime determinant of whether agricultural soils act as a source (net loss) or a sink (net gain) for atmospheric carbon. Organic carbon (such as humus) has many benefits in soils, making effective carbon management the key factor for productive farms, revitalised catchments and a greener planet.

In Australia, comparatively little research has been directed towards management practices that enhance carbon sequestration in soils, yet this is the component of our biosphere from which most carbon has been lost and the component with the greatest potential for storage.

Carbon credits
Carbon dioxide is one of the ‘greenhouse gases’ considered by some scientists to contribute to global warming and climate change. ‘Carbon credits’ apply to activities that reduce the levels of carbon dioxide accumulating in the atmosphere. There are a large and rapidly growing number of carbon trading schemes in the world, some of which date back to as early as 1995. A carbon trade can simply be an agreement between two parties. For the term ‘carbon credits’ to be used, the emission reduction or biosequestration to which the credits apply must be subject to verification by an accredited certificate provider.

One credit, as designated by an emission trading, emission reduction, renewable energy or abatement certificate, represents one tonne of carbon dioxide equivalent. Carbon credits for sequestration are a type of offset trade and the carbon storage may be leased or sold. Simply stated, the entity emitting the carbon buys registered certificates and the entity sequestering carbon sells them (ie receives money for carbon storage). A ‘trade’ occurs when carbon credits are secured and then surrendered or acquitted through an accredited carbon broker, carbon exchange or carbon registry.

The Chicago Climate Exchange (CCX) in North America began greenhouse gas allowance trading in 2003. Members include over 350 companies and public sector entities in the Unites States, Australia, Brazil, China, India and Costa Rica. When the European Union’s Emission Trading Scheme (EU-ETS) scheme was launched in the early part of 2005, the volume of trade exceeded all expectations, leading to the launch of the European Climate Exchange (ECX).

The first government legislated carbon trade in Australia, valued at over one million dollars, was registered in March 2005, between Forests NSW and Energy Australia. The ‘carbon credits’ were for carbon sequestered in hardwood timber plantations in northern NSW. Globally, trading in carbon is a multi-million dollar industry. Forecasters have suggested that carbon is poised to become the world’s largest commodity market, generating financial innovation in hedge funds, futures and derivates. Carbon emissions are currently viewed as a global ‘problem’ and credits for both emission reduction and carbon sequestration are seen by many governments as an important part of the global ‘solution’.

‘Carbon credits’ for regenerative land management could help to cash flow the multiple natural resource management and environmental benefits that accompany increased levels of carbon in soils. In North America, soil carbon has been traded through the Chicago Climate Exchange since April 2003.

Managing the carbon cycle
Since the European settlement of Australia, 50-80% of carbon has been lost from most farmed soils, often as a direct result of the loss of the soil itself. Even today, most farming businesses continue to lose soil carbon - their most valuable asset. As a result, landholders invest a great deal of time and effort attempting to make ‘dead’ soils productive.

Carbon equilibrium levels in soil are determined by carbon inputs and outputs, which in turn are influenced by temperature, rainfall and management. In general terms, soil carbon accumulation is positively correlated with rainfall and negatively correlated with temperature. That is, more carbon can be stored in soil in cold, moist environments than in hot, dry ones. Landholders cannot 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.

The importance of groundcover

Groundcover includes plants, plant litter and crop stubbles. Living plants, especially perennials, provide the most important form of groundcover for carbon sequestration. Green plants are the conduit between the atmosphere and the soil and provide the 'way in' for soil carbon. People cannot function without skin or a circulatory system. Soil cannot function without cover and the root systems and fungal networks that form the 'liquid carbon pathway' – that is, the carbon supply chain.

Carbon dioxide drawn from the atmosphere through the process of photosynthesis in green leaves is converted to glucose which in turn is transformed to a large variety of carbon compounds within the plant, many of which are exuded into soil from actively growing roots. The most important 'carbon highway' in soil is that created by the hyphae of mycorrhizal fungi. Hence it is important to have a large volume of living, fibrous roots in soil at all times of the year - even in cropping enterprises.

Soils under healthy perennial pasture may contain hundreds of tonnes of carbon per hectare and sustain high levels of microbial activity. These conditions provide an excellent base for an annual crop, provided the perennial groundcover remains.

Regenerative land management

There is little organic carbon left to lose from the surface horizons of many farmed soils. A widespread misconception in the Australian scientific community is that the carbon lost from our deeply weathered and fragile soils cannot be put back.

The good news is - it CAN!! Putting the carbon back will require the adoption of regenerative farming and grazing methods that result in the active formation of new topsoil. Carbon cannot be sequestered in soils if the forms of land management that cause carbon losses are continued.

Managing groundcover for increased soil carbon levels results in improved soil structure, lower bulk density, greater porosity, higher infiltration rates, more effective use of rainfall, enhanced water quality, higher cation exchange capacity, greater sequestration of nitrogen and sulphur, enhanced availability of phosphorus and trace elements, reduced costs, reduced inputs, improved biodiversity and increased productivity.

These positive outcomes are all linked to what could be the core business of EVERY farm business – the sequestration of atmospheric carbon. There is no doubt that with changes to management regimes, significantly more carbon can be stored in our soils than they currently hold.

Building new topsoil

New topsoil is formed when the level of soil carbon is increased. In pastoral regions, some form of rest-rotation grazing regime will be required, aimed primarily at improving the quantity and vigour of groundcover and associated root biomass. In mixed farming and croplands, innovative techniques such as Pasture Cropping and Perennial Cover Cropping will optimise year-round green groundcover, support mycorrhizal networks and enhance the production and humification of rhizosphere exudates.

Measuring soil carbon

Soil carbon content is usually expressed as either a concentration (%) or a stock (t/ha). Unless the depth of measurement and soil bulk density parameters are known, it is not possible to accurately convert from one unit of measurement to the other.

The soil carbon stock (tC/ha) including organic carbon, inorganic carbon and phytoliths (silica occluded carbon) is the cumulative total determined by multiplying the carbon concentration (%) by the bulk density (BD) for each depth increment measured. Tonnes of carbon dioxide sequestered per hectare (tCO_2/ha) are calculated by multiplying the carbon stock by 3.67.

Soil bulk density (g/cm^3) is the dry weight (g) of one cubic centimetre (cm^3) of soil. It is generally in the range 1.0 to 1.8 g/cm^3. Bulk density varies for different soils and different soil depths. Soils of low bulk density are well structured and have 'more space than stuff'. The lower the bulk density the more room for air and water and the better the conditions for soil life and nutrient cycling. Bulk density generally increases with soil depth. The higher the bulk density the more compact the soil. For the purposes of illustration, an average bulk density of 1.4 g/cm^3 was assumed for the calculations in Table 1.

CO_2 equivalent. Every tonne of carbon lost from soil adds 3.67 tonnes of carbon dioxide (CO_2) to the atmosphere. Conversely, every one tonne increase in soil carbon represents 3.67 tonnes of carbon dioxide sequestered from the atmosphere.

Another way of expressing this relationship is that every 2.7 tonnes of carbon sequestered in soil represents 10 tonnes of carbon dioxide removed from the atmosphere.

Australian Soil Carbon Incentive Payments

Most current contracts for trading carbon sequestered in timber are based on the '100 year rule' that is, the carbon pool for which carbon credit payments are received must be maintained for 100 years, or in some situations, longer. This involves a high degree of risk.

Under the Australian Soil Carbon Accreditation Scheme, Soil Carbon Incentive Payments are paid annually and retrospectively, at one-hundredth the 100-year rate, for carbon sequestered in predetermined Defined Sequestration Areas (DSAs). This is similar to being paid 'on delivery' for livestock or grain, eliminating risk.

Table I shows what this might look like in terms of dollars per hectare per year, for a net soil carbon increase of 0.15% (in absolute terms) every year for three years, in the 0 -110cm soil profile. This level of increase in soil carbon is achievable by landholders practicing regenerative cropping and grazing practices.

Table 1: Increase in total soil carbon stocks in tonnes per hectare (tC/ha), tonnes of carbon dioxide equivalent sequestered per hectare (tCO_2-e/ha) and value in dollars per hectare ($/ha) [at one hundredth the 100 year rate of $25/tonne CO_2-e], for estimated total soil carbon net increases of 0.15%pa, 0-110 cm, BD 1.4g/cm^3, over a three year period.

Year	Net % increase	tC/ha	tCO_2-e/ha	$/ha
1	0.15	23.1	84.78	21.19
2	0.30	46.2	169.55	42.39
3	0.45	69.3	254.33	63.58
TOTAL				**127.16**

Annual retrospective per hectare payments (final column Table 1) increase in line with progressive increases in soil carbon from the measured baseline. The figure of $127.16 is a three-year total.

The upper limit to soil carbon accumulation will vary according to environmental parameters. In many situations soils should be able to sequester around five times their current level of organic carbon.

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