Occasional Paper

Australian Farm Institute

No. 21.01 | August 2021

An everyman's guide for a landholder to participate in soil carbon farming in Australia

Robert E White, Brian Davidson and Richard Eckard

Faculty of Veterinary and Agricultural Sciences, University of Melbourne

Soil carbon farming has been promoted as one of the key strategies for offsetting Australia's greenhouse gas emissions, with the ancillary benefit of improving soil health and farm productivity. This article explains in simple terms the procedures for a farmer to participate in the Australian Government's Emissions Reduction Fund. It evaluates national and international scientific data on annual rates of soil carbon storage, in tonnes carbon per hectare.30 cm, for several environments, which are compared with some of the exaggerated claims made by commercial aggregators. Project compliance costs, which are variable, are compared with the possible income from carbon credits. However, the overriding metric determining whether a project is financially viable is the opportunity cost of changing the land management practice, which generally far exceeds the net income from carbon credits. However, the benefit-cost ratio could become more favourable if the value of ecosystem services provided by an improved soil condition could be realised.

Introduction

Following the release of the Australian Government's Technology Roadmap (Department of Industry Science Energy and Resources, 2020), the debate about the viability of soil carbon storage as an offset for Australia's greenhouse gas emissions has intensified. This debate has bubbled along for the past decade, but in recent times commercial aggregators have signed up landholders in more than 130 soil carbon projects under the government's Emission Reduction Fund (now rebranded the Climate Solutions Fund), or under other schemes sponsored by voluntary carbon market brokers. Often the claims made for soil carbon are exaggerated compared with values reported in the scientific literature. Although having adequate soil carbon, the major constituent of soil organic matter, has long been recognised as important for soil health and soil fertility, the main aim of the current push for soil carbon build-up is earning money from carbon credits.

We address the uncertainty of outcomes for landholders from the perspective of what increase in soil carbon storage is achievable, and whether income is likely to exceed a project's costs

This article provides a simple guide as to what is possible for a sustained increase in soil carbon under various climatic and land management activities, and estimates the costs and benefits of such activities.

What are the options?

The Emissions Reduction Fund, administered by the Clean Energy Regulator, provides the main avenue for a landholder to earn income from soil carbon farming. Participants can bid to provide carbon abatements, called offsets, through approved land management practices. These offsets are in the form of Australian Carbon Credit Units (ACCUs), with one ACCU providing one tonne (t) of carbon dioxide equivalent (CO_2-e) of abatement. The CO_2-e concept accounts for all radiatively active gases, including emissions of methane and nitrous oxide associated with land management. The ACCUs can be contracted to the government, which means they count as an offset to Australia's reported emissions. However, landholders may choose to sell their credits at a similar price in the more flexible voluntary market.

In the current marketing of soil carbon farming, not only are many Australian aggregators importuning landholders to sign up to soil projects, but foreign companies are also involved in the Australian market. However, because of non-conforming or untested methodologies, carbon credits earned through such companies do not necessarily have the integrity of the rigorously-vetted ACCUs and therefore cannot be counted as verified offsets. Moreover, even if this type of credit were valid, when it is sold to an overseas investor it cannot be counted as an offset to Australian emissions.

Disincentives to participants in soil carbon farming under the Emissions Reduction Fund are its complexity, permanence obligations, compliance costs and uncertainty of outcomes. For these reasons, landholders may be attracted to the more lenient foreign schemes that appear to offer better rewards. The issue of compliance costs is being addressed through a re-design of the methodology and the offering, in a pilot scheme, of an up-front cash advance to defray the cost of a project's establishment. However, in this article we address the uncertainty of outcomes for individual landholders from the perspective of what increase in soil carbon storage is achievable, and whether the income from carbon credits is likely to exceed a project's costs, including the opportunity cost.

Key questions posed on the Emissions Reduction Fund website

As a first step for a landholder considering a soil carbon project, the Clean Energy Regulator poses the following questions.

1. ***Are you looking to store carbon in soil in a grazing or cropping system, including perennial woody horticulture?***
2. ***Are you willing to undertake one or more new land management activities to increase soil carbon?***

The reason for this question is that simply continuing the current land management, which may well be storing soil carbon, provides no additional contribution to offsetting emissions – the status quo is maintained. This concept of additionality is also a condition of reputable foreign toolkits such as COMET-Farm (https://toolkit.climate.gov › tool › comet-farm). The Clean Energy Regulator's website gives a list of eligible activities, each of which must be a new activity or a significant change from an existing activity. The website also explains what is not acceptable practice for a given activity, e.g. destocking of grazing land unless being converted to cropland, use of ineligible non-synthetic fertiliser, use of soil amendments including coal, use of pyrolysed material that is not biochar (special rules apply to biochar). The rationale for these restrictions is based on the concept of additionality and the non-transfer of organic material from elsewhere to the project site. Organic materials generated and applied within a site are permitted.

3. ***Are you willing to measure the increase in soil carbon?***

The protocols for measuring soil carbon and any changes in soil carbon storage (based on an equivalent soil mass basis) are comprehensively set out on the website. They involve a sequence of soil samplings to at least 30 cm depth and carbon analysis either by an accredited laboratory or properly calibrated sensors. Any changes in soil bulk density between sampling times also need to be taken into account.

4. ***Are you willing to maintain stored carbon for at least 25 years after the first Australian carbon credits units are issued?***

This period is the minimum period for which carbon must be stored to be called 'sequestered' (although true sequestration should be for >100 years). It should be noted that carbon credits earned in a 25-year contract are discounted by 25%, and that a further discount may apply if the measured soil carbon values are very variable. It is not clear in some of the foreign schemes whether such a permanence period is required.

If a landholder answers 'yes' to these questions, bearing in mind the provisos briefly identified above, there is an additional question that should be asked.

5. ***Do you want to improve your farm business's profitability by engaging in a soil C project? If so, have you considered how this will be achieved – what are the key criteria for success?***

The answer to this last multiple question depends firstly on the answer to the following question.

What are the chances of success in increasing soil carbon?

Soil carbon dynamics

Put simply, soil organic matter is in a dynamic balance between inputs of organic materials and their decomposition by microorganisms and soil animals. Being a dynamic balance reflects the fact that the carbon content changes with time, depending on the influence of plant inputs and environmental factors that affect plant growth and the soil's biological activity. Because inputs and environmental factors vary spatially, the soil carbon content at any one time also varies spatially. These effects present challenges for measurement, especially when small changes must be measured against a large background of soil carbon.

For a given site under stable management, soil organic matter attains a steady-state equilibrium, which in Australia is primarily determined by rainfall. When either the inputs or outputs through removals or decomposition are changed, the system moves to a new steady-state, when its dynamic balance is restored. The new steady-state is approached asymptotically (i.e. reaches a plateau), usually with interannual variability depending on seasonal conditions. As a first approximation, however, one can assume a linear change during the first five years or so, barring a radical change in conditions. The time taken to reach the new state ranges from 20 to 100 years (Soussana et al., 2004).

Based on knowledge of the influencing factors and their interactions, one can project through process modelling what rates of change in soil carbon are expected for different regions under different land managements. These projections can be compared with the results of field experiments where changes have been measured. Overall, this dual approach provides realistic guidance as to what can be achieved in soil carbon farming.

Modelled examples

The methodology 'Estimating Sequestration of Carbon in Soil Using Default Values' is an example of model projections for soil carbon (Australian Government, 2015). Based on the Full Carbon Accounting Model (FullCAM), landholders could obtain an estimate of potential carbon sequestration for several project management activities. Table 1 (over page) gives a summary of these estimated values.

Table 1: Modelled sequestration values (t CO_2-e/ha/year) for a given management activity in regions of different sequestration potential.

	Categories of sequestration potential[1]			
Project management activity	**Ineligible land (not modelled)**	**Marginal benefit**	**Some benefit**	**More benefit**
Sustainable intensification[2]	No value	0.11 (0.03)	0.59 (0.16)	1.65 (0.45)
Stubble retention	No value	0.07 (0.02)	0.29 (0.08)	0.73 (0.20)
Conversion to pasture	No value	0.22 (0.06)	0.44 (0.12)	0.84 (0.23)

1 Figures in parenthesis are t C/ha/year

2 Sustainable intensification can involve new irrigation, fertiliser, liming or pasture renovation

The distribution of these regions in Australia was shown in an on-line map. Areas of potential carbon sequestration for the whole of Australia mapped at a very small scale are of little use to individual landholders. However, the map showed that the regions of 'some' and 'more benefit' were concentrated in the higher rainfall areas of eastern Australia. For Western Australia, there was only a small area of such benefits in the extreme southwest.

Ranging from 0.08 to 0.45 t C/ha/year for regions of 'some' and 'more' benefit, the estimates in Table 1 are conservative, especially for conversion to pasture. Meyer et al. (2015) provided more refined estimates, using the Sustainable Grazing Systems model (Johnson et al., 2003), by simulating pasture growth on initially low and high carbon soils under two rainfall regimes – 676 mm, representative of Hamilton in Western Victoria, and 355 mm, representative of Birchip in northwest Victoria. The simulations were run for three 20-year periods between 1901 and 2011 to minimise the effect of climate variability. The rate of carbon increase was most sensitive to initial soil carbon content, ranging from 0.30 to 0.45 t C/ha/year in the low carbon scenarios. Rainfall had a more significant effect in the high soil carbon scenarios due to its effect on pasture growth and mineralisation of soil organic nitrogen (N). Using simulation modelling of several crop-pasture rotations under rainfall regimes of 330 to 700 mm rainfall in Victoria, Robertson and Nash (2013) projected increases in soil carbon, with stubble retention, of 0.3–0.9 t C/ha/year over 25 years; but they cautioned that such increases could take 10–25 years to be measured with certainty.

Field measurements

Results have been reported for several trials of varying duration in New South Wales. For example, Badgery et al. (2020) reported on trials on farms in the Cowra Trough, central west NSW (rainfall 673 mm). Farms were selected based on the soil carbon increase predicted from a Soil Carbon Calculation Tool (Murphy et al., 2012) when the farmers changed their management in accordance with Emission Reduction Fund requirements. Measured values were derived from baseline sampling in 2012 and again in 2017. Table 2 (next page) gives the results for five farms where the management change was from cropping to pasture without organic amendments.

Several points should be noted.

- The initial soil carbon stores were low, which increased the likelihood of carbon accumulation when management was changed.
- There was considerable variation in the measured means for soil carbon change, reflecting the spatial variability in soil carbon in the field.
- There was a large difference between the model predictions and measured values of soil carbon change. This suggests that either the model was too simplistic or the carbon processes in the model were not correctly parameterised for these soils and this environment, or both. It is noteworthy that a previous survey of farm paddocks converted from cropping to pasture in the region found an average increase in soil carbon of 0.78 t C/ha/year over five

years (Badgery et al., 2014). This figure lies between the average measured and modelled values of 0.97 and 0.34 t C/ha/year, respectively, shown here.

The upper limit to soil carbon increase in soils of the Cowra region is close to 1 t C/ha/year during the initial years of conversion of crop land to pasture. This rate is likely to decrease with time as the soil approaches a new steady-state equilibrium. For example, in a similar region of NSW, but for longer term trials of 13 and 25 years, Chan et al. (2011) reported increases of 0.40 and 0.26 t C/ha/year, respectively.

Conclusion from the biophysical data

The United States Department of Agriculture (Ogle et al., 2014) concluded that conversion to pasture leads to increases in soil carbon, ranging from 0.5 t C/ha/year in rangelands to 0.84 t C/ha/year in more intensively managed pastures. These figures are outside the average of 0.47 t C/ha/year reported from 126 grassland studies around the world (Conant et al., 2017). However, for the mixed farming belt of inland NSW, Chan et al. (2011) concluded that improved soil nutrient inputs and grazing management could lead to increases of 0.5-0.7 t C/ha/year, provided the initial soil carbon levels were well below the steady-state concentrations that would be expected after such improved management.

That the soil carbon increases reported here range from 0.26 to 1 t C/ha/year reflects the variable influence of initial soil carbon content, rainfall, soil type, intermittent tillage (in pasture-crop rotations), nutrient inputs and grazing management on individual farms. However, Table 3 gives examples of much larger soil carbon increases claimed by some aggregators in the marketplace.

These claims are exceptional and need to be scrutinised more closely because farmers

Table 2: Changes in soil carbon store after a change from cropping to pasture in a 5-year on-farm trial in the Cowra Trough, NSW (from Badgery et al., 2020).

Farm identifier (all farms >200 ha)	Initial soil C store (t C/ha to 30 cm)	Predicted change in soil C store (t C/ha/year)	Measured change in soil C store (t C/ha/year)[1]
LA0690	27.1	0.41	1.01 ± 0.16
LA0700	28.2	0.3	0.58 ± 0.43
LA0725	31.9	0.2	0.78 ± 0.29
LA0934	20.9	0.5	1.13 ± 0.16
LA0734	28.6	0.3	1.33 ± 0.18
Means	27.3	0.34	0.97

1 Mean and standard error derived from a minimum of 10 composite samples according to a stratified random design.

Table 3: Examples of soil carbon increases claimed by some aggregators

	Quoted increases in soil C (t CO2-e in brackets)			
Source	Tonnes C /ha. 30 cm/year	Tonnes C/ha.30 cm (no time specified)	Tonnes C/ha. 10 cm	Tonnes C/ha. 15 cm
Agriprove (1)[1]	3.05 (11.2)			
Agriprove (2)[2]		33.8 (124)		
Resource Consulting Services[3]			9.6 (35.2)	
Regen Networks Development[4]				6.2 (22.9)

[1]www.agriprove.io

[2]www.agriprove.io/build-carbon

[3]www.youtube.com/watch?v=rQhoH3dX0Jo

[4]Wilmot Report 2019_ Grassland credits.pdf (regen-registry.s3.amazonaws.com)

may register for projects having unrealistic expectations. Moreover, to achieve a valid greenhouse gas offset, any increase in soil carbon following the land management change must be balanced against the net change in all emissions, i.e. accounting for emissions (expressed in CO_2-e) before and after the management change. Even if there is a valid offset, the income accrued from the carbon credits needs to be compared with the change in overall farm income to determine whether carbon sequestration is financially viable or not. This criterion is evaluated in the next section.

What are the actual and potential benefits and costs?

The costs of a project registered with the Clean Energy Regulator fall into two categories.

1. Costs of establishing the project – engaging the services of an aggregator, compilation of records for previous 10 years, the initial site survey, costs of soil sampling by a qualified technician and carbon analysis by an approved method.
2. Costs associated with the changed management activity, e.g., cropland to pasture, changed fertiliser inputs, changed grazing management, cost of permissible inputs and opportunity cost.

The benefits of the project can be categorised as:

3. Improved productivity under the new land management and hence increased profitability of the farm business.
4. Income earned from the sale of carbon credits either under government contract or on the voluntary market.
5. Co-benefits such as improved ecosystem services and biodiversity.

The worth of the changed management activity depends on the type of activity and the region. Some illustrative examples of this cost/benefit relationship are discussed in the next section.

Examples of the costs and benefits of a practice change

The economic impacts of management changes may be estimated by expanding the model White and Davidson (2016) developed to assess the opportunity cost, calculated as a gross margin, of changing from various cropping activities to livestock production. The total net cost of undertaking activities to sequester carbon is achieved by adjusting their model.

For example, the fee charged by an aggregator for steering a project through the requirements of the Clean Energy Regulator and on-going compliance can range from 18 to 44% of the carbon credit income. (The fees may cover a third-party audit fee and the cost of site survey, sampling and soil analysis). Anecdotally, estimates of the cost of soil sampling and analysis vary from as high as $100/ha to as low as $30/ha, depending on the size of the area and sampling strategy. Singh et al. (2012) investigated these costs in a study of different sampling strategies on a 68-ha cropping field in central-western NSW. The aim was to measure the soil carbon store with a standard error of less than 2 t C/ha, which meant being able to detect with adequate certainty a change in soil carbon at the rate of 0.4 t C/ha/year during an initial period of five years. Their estimate was approximately $2500, which came to $37/ha. Malcolm et al. (2014) estimated the cost of pasture establishment as $400/ha in eastern Australia. Table 4 (next page) gives examples of the gross margins for changing from dryland cropping to livestock (from NSW Department of Agriculture data reported in White and Davidson (2016), adjusted from ABARES survey data in *Agricultural Outlook* – Department of Agriculture). A negative figure in this table means there is a decrease in gross margin and a positive figure indicates an increase in gross margin for the practice change.

Clearly there is a significant net cost associated with each practice change. However, the result of this analysis will be affected by the relative costs of inputs and value of outputs. To demonstrate such effects, sensitivity tests were performed on the data in Table 4 and the results are shown in Table 5 (over page). All the tests were set up to make the change more favourable to storing carbon and earning ACCUs.

Table 4: Gross margins and total net costs ($/ha) for changing from dryland cropping to livestock production.

From…	Soybeans		Maize		Wheat		Lucerne	
To …	Opportunity cost	Total net cost	Opportunity cost	Total net cost	Opportunity cost	Total net cost	Opportunity cost	Total net cost
Cattle								
1 year	-341.30	-812.46	-300.57	-771.73	-386.43	-857.59	-255.88	-727.04
7 years	-2136.93	-2524.56	-1182.51	-1570.14	-1552.74	-1940.37	-2494.36	-2881.99
Sheep								
1 year	-443.51	-914.66	-402.78	-873.93	-488.64	-959.79	-358.09	-829.24
7 years	-2990.17	-3377.80	-2035.75	-2423.38	-2405.98	-2793.61	-3347.61	-3735.23

Notes: Opportunity costs are the changes in gross margins only.

The 7-year projections are based on a discount rate of 5%.

The total net cost includes the opportunity cost, the cost of pasture establishment ($400/ha), cost of soil tests ($100/ha) and aggregator's fee (18% of ACCUs earned), defrayed by the current value of an ACCU ($15.99), discounted by 25% for 25-year contract, and assuming carbon stored at the rate of 0.8 t C/ha/year.

Average stocking rates for dryland livestock were 2.0 and 0.45 head/ha in NSW for sheep (ewes with lambs) and cattle, respectively.

The only change that improved the outcome is a 50% reduction in the yield of an existing crop, and then only after 7 years (when the changes are greater than 100%). The other significant change occurs if the yield of livestock is doubled, but then not enough to make the change profitable, except for maize to cattle. All other changes – increasing carbon stored to 2 t/ha/year, reducing soil testing costs by $50/ha, increasing the carbon price to the international price – result in only minor reductions in the losses shown in Table 4.

What is the overall outcome of soil carbon farming under the Emissions Reduction Fund?

Increasing soil carbon is often stated to have important co-benefits such as improved soil structure, water holding capacity, cation exchange capacity and soil biological function, reflected in improved soil health. We suggest that such benefits will be incorporated into any increase in productivity and land value, as determined in the marketplace: these are private benefits that accrue directly to the landholder. There are also the benefits of ecosystem services such as less erosion and hence better water quality, associated with a more stable soil structure: these are more difficult to quantify and are also variably split between private and public good. Nonetheless, co-benefits such as improved biodiversity may be captured through other government incentives such as the recently launched pilot program for Carbon + Biodiversity (Carbon + Biodiversity Pilot agriculture.gov.au). Under the pilot, farmers who plant native trees will be paid upfront for biodiversity outcomes, and subsequently should earn carbon credits from the plantation. However, the focus of this program is on unproductive land or productive land that can improved by targeted tree planting.

From the perspective of soil carbon, co-benefits and associated productivity increases, where achieved, could be of greater benefit than possible soil carbon credits

There may be several reasons why a farmer might engage in a soil carbon farming project. However, because in large areas of Australia rainfall is limiting for plant growth, sustained increases in stored soil carbon >1 t C/ha/year, even under the most favourable land management, are difficult to achieve. Furthermore, the financial outcome from carbon credits alone is dubious, given the low value of ACCUs, project compliance costs and overall, the opportunity cost associated with making a land management change. Farmers should be aware that the exaggerated claims made by many carbon aggregators are not necessarily achievable. From the perspective of soil carbon, the aforementioned co-benefits, where they can be valued, and associated productivity increases, where achieved, could be of greater benefit than possible soil carbon credits.

References

Australian Government (2015), *Carbon Credits (Carbon Farming Initiative) Estimating Sequestration of Carbon in Soil Using Default Values, Methodology Determination 2015.* www.comlaw.gov.au/Details/F2015L01163.

Badgery, W, Murphy, B, Cowie, A, Orgill, S, Rawson, A, Simmons, A & Crean, J (2020), Soil carbon market-based instrument pilot – the sequestration of soil organic carbon

Table 5: Sensitivity tests showing the percentage change in total net costs in Table 4 for a land management change.

Activity changed from…		Soybeans	Maize	Wheat	Lucerne
To …					
Crop yields down by 50%					
Cattle	1 year	58	70	59	85
	7 years	118	195	144	150
Sheep	1 year	51	62	53	75
	7 years	88	127	100	116
Carbon stored at 2 t/ha/year					
Cattle	1 year	5	6	5	6
	7 years	10	16	13	9
Sheep	1 year	5	5	5	5
	7 years	7	10	9	7
Cost of soil tests down 50%					
Cattle	1 year	6	6	6	7
	7 years	3	6	4	3
Sheep	1 year	5	6	5	6
	7 years	3	4	3	2
Increase in ACCU price to $23 per unit					
Cattle	1 year	2	2	1	2
	7 years	3	5	4	3
Sheep	1 year	1	1	1	2
	7 years	2	3	3	2
Doubling the yield of livestock					
Cattle	1 year	32	34	30	36
	7 years	70	113	91	62
Sheep	1 year	24	26	23	27
	7 years	38	53	46	35

Note: A change of 100% or more means that the management change is profitable overall.

for the purpose of obtaining carbon credits, *Soil Research* 59, pp. 12-23. doi.org/10.1071/SR19331.

Badgery, WB, Simmons, AT, Murphy, BW, Rawson, A, Andersson KO & Lonergan, VE (2014), The influence of land use and management on soil carbon levels for crop-pasture systems in Central New South Wales, Australia. *Agriculture, Ecosystems & Environment* 196, pp. 147–157.

Chan, KY, Conyers, MK, Li, GD, Helyar, KR, Poile, G, Oates, A & Barchia, IM (2011), Soil carbon dynamics under different cropping and pasture management in temperate Australia: results of three long-term experiments, *Soil Research* 49, pp. 320–328 doi:10.1071/SR10185.

Climate Solutions Fund (2020), Understanding your soil carbon project, V4.0 17. Australian Government, Canberra.

Conant, RT, Cerri, CEP, Osborne, BB & Paustian, K (2017), Grassland management impacts on soil carbon stocks: a new synthesis, *Ecological Applications* 27(2), pp. 662–668.

Department of Industry Science Energy & Resources (2020), First Low Emissions Technology Statement – 2020, Australian Government, Canberra.

Johnson, I, Lodge, G, & White, R (2003), The sustainable grazing systems pasture model: description, philosophy and application to the SGS National Experiment, *Animal Production Science* 43, pp. 711–728.

Malcolm, B, Smith, KF & Jacobs JL (2014), Perennial pasture persistence: the economic perspective, *Crop and Pasture Science* 65, 713-720, doi.org/10.1071/CP13419.

Murphy B, Rawson A, Badgery W, Crean J, Pearson L, Simmons A, Andersson K, Warden E, & Lorimer-Ward K (2012), Soil carbon science to support a scheme for the payment of changes in soil carbon – lessons and experiences from the CAMBI pilot scheme, *Proceedings of the 5th Joint Australia and New Zealand Soil Science Conference*, Hobart, Tasmania (Eds L Burkitt & L Sparrow) pp. 255–258, Australian Society of Soil Science Incorporated: Hobart.

Meyer, R, Cullen, BR, Johnson, IR & Eckard, RJ (2015), Process modelling to assess the sequestration and productivity benefits of soil carbon for pasture, *Agriculture, Ecosystems and Environment* 213, pp. 272–280.

Ogle, SM et al. (2014) Chapter 3. Quantifying greenhouse sources and sinks in cropland and grazing land systems, *Quantifying gas fluxes in agriculture and forestry: methods for entity-scale inventory* (eds M. Eve et al.), Technical Bulletin 1939, Office of the Chief Economist, US Department of Agriculture, Washington D.C.

Robertson, F & Nash, D (2013), Limited potential for soil carbon accumulation using current cropping practices in Victoria, Australia, *Agriculture, Ecosystems & Environment* 165, pp. 130-140. http://dx.doi.org/10.1016/j.agee.2012.11.004.

Singh K, Murphy BW & Marchant BP (2012), Towards cost-effective estimation of soil carbon stocks at the field scale. *Soil Research* 50, pp. 672–684. doi:10.1071/SR12119.

Soussana, J-F, Loiseau, P, Vuichard, N, Ceschia, E, Balesdent, J, Chevallier, T & Arrouays, D (2004), Carbon cycling and sequestration opportunities in temperate grasslands, *Soil Use and Management* 20, pp. 219–230.

United States Department of Agriculture (2021), Comet-Farm. Natural Resource Conservation Service, Colorado State University.

White, R & Davidson, B (2016), The costs and benefits of approved methods for sequestering carbon in soil through the Australian government's Emissions Reduction Fund, *Environment and Natural Resources Research*, 6(1), pp. 99-109.