Soil Carbon Projects: A pathway to sustainability, global agricultural productivity, and meaningful climate action

Duncan Farquhar[1], Melanie Addinsall[2], Andrew Bremner[3], Kieren Whittock[4], Matthew Warnken[5]

[1, 2, 3, 4, 5] Soil Carbon Industry Group, Australia, [2, 3, 4, 5] AgriProve Pty Ltd, Australia
Email: [1]Duncan.J.Farquhar@outlook.com, [5]matthew.warnken@agriprove.io

Editorial review: This article has been subject to an editorial review process.

Abstract

The Australian 2021 Soil Carbon Method (2021 Method) enables drawdown of atmospheric CO_2 to soil. The 2021 Method creates a basis for project development and a market for trade in soil carbon Australian Carbon Credit Units. Standardised measurement, innovation in farm management, and monetary incentives are keys to its success. This paper reports on the early successes of industry participants. Soil carbon markets are an emerging paradigm in sustainability culture.

Official and private sources are used to tabulate data from the first projects to earn soil carbon credits under the ACCU (Australian Carbon Credit Unit) Scheme. A new index of sustainability culture, Soil Carbon Effective Sustainability Culture Index (SCESCI), measured in years, is presented. Globally, over 150 Gigatonnes of soil carbon has been lost from agricultural soils. Replacing this carbon pool would draw down much of the current excess of atmospheric carbon. The related step-change increase in agricultural productivity is significant to global security in a changing world. Monitoring SCESCI at national and regional levels is a success indicator for required transformative change with speed and scale.

Keywords: *sustainability culture index; soil carbon; ACCU; carbon removal; soil carbon sequestration*

Introduction

Soil carbon projects are parts of a system whereby farmers are given an incentive through carbon markets to increase on-farm soil carbon. These projects are delivering landscape-scale regeneration whilst sequestering atmospheric carbon in soils. This system is described below as a needed advance in sustainability culture that is gaining momentum.

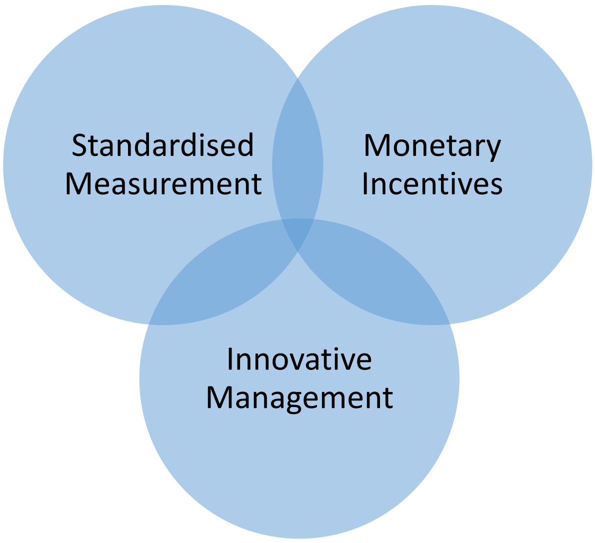
Soil carbon is the key indicator of soil health. It feeds microbiological communities, which play a key role in healthy soil structure and function, nutrient fixation and cycling, and resilience against pests and disease. Regenerative grazing practices (**Machmuller & Dillon, 2021**) encourage full groundcover and maximise biomass, which reduces erosion and nutrient runoff, increasing water quality. Regenerative management to increase diversity, such as the use of multi-species pastures, increases insect populations and diversity, which in turn supports broader landscape biodiversity and pollination. A range of ecological services and natural capital co-benefits can be linked to good soil health as measured by increased soil organic carbon (**Lehmann et al., 2020**). These soil health advantages and increases water holding capacity from sequestered soil carbon, also increase agricultural productivity. The need for change in managing soil carbon has imperatives from ecological, productivity and climate perspectives.

Operation of the global economy in the Anthropocene has been driven by extractive industries based on fossil fuels (**Ashworth, 2022**; **Foster, 2024, 2024**; **Fu et al., 2023**; **Görg et al., 2020**; **Oldfield et al., 2014**; **Peša & Ross, 2021**; **Stephens, 2022**; **United Nations, 2021**). The need to move away from extractive fossil-based energy systems and toward renewable energy sources is well understood from a policy perspective and also from an operational and investment standpoint (**Gielen et al., 2019**; **Gielen & Boshell, 2021**; **United Nations, 2024**). Conversely, the need to move away from extractive agricultural systems and towards regenerative systems is only beginning to be articulated. Agriculture is far behind energy systems in terms of policy, operational, and investment imperatives (**Massy, 2020**; **Masterton, 2021**; **Schulte et al., 2022**).

Soil carbon is currently the fastest growing category under the ACCU Scheme, now with 712 registered soil carbon projects (**Clean Energy Regulator, 2025**). The 2023 Proceedings of the Soil Carbon Industry Summit (**Farquhar et al., 2023**) present a snapshot of the Australian soil carbon industry. Previous reviews (**McDonald et al., 2023**) have revealed management impacts on soil carbon. New results from the soil carbon projects credited under the Australian ACCU scheme offer emerging evidence of transformational, cultural, and systemic change. Creating and sustaining a culture of regenerative agriculture has the potential to positively disrupt existing extractive agriculture systems and decelerate climate change. This paper presents data from these early crediting soil carbon projects under the Australian ACCU Scheme.

Investing, through offset markets, in the cultural change from extractive to regenerative agricultural systems promises to deliver better results for people, profit, and the planet (**Honegger et al., 2021**). The opportunity exists to quantify parts of a regenerative agriculture (**Jayasinghe et al., 2023**) and incentivise innovative management practices that meet emerging Environment, Social and Governance (ESG) markets. Three components are necessary: 1) standardised measurement (**Dupla et al., 2024**), 2) innovative farm management practices (**Field et al., 2024**), and 3) monetary incentives (**Amin et al., 2020**). These components are brought together by companies and landowners implementing the 2021 Soil Carbon Method under the Australian Carbon Credits Units (ACCU) scheme.

Figure 1: ESG (Environmental Social Governance) markets driving transformative change from extractive to regenerative agricultures and systems.



Standardised Measurement

The Australian 2021 Soil Carbon Methodology has a legislated protocol requiring the physical sampling and measurement of soil carbon stock (**Australian Government Federal Registrar of Legislation, 2021**). Importantly, the 2021 Method includes a measurement-and-models approach to soil carbon measurement. Regular randomised physical sampling and laboratory analysis of soil carbon to one metre depth is required. These measures can be used to verify modelling with analytical measures of carbon stock, meaning that any modelling used in the project has an integrity check of physical sampling at the project level. This internal verification does not rely on publicly available data of variable applicability and depth that have been used for training other models (FullCAM, for example) (**Richards & Evans, 2004**). The 2021 Method details how modelling can be included in projects, providing a commercial incentive for the development of models that are effective in better understanding carbon stock at the project level. Under the 2021 Method, measurement is required where modelling is an optional enhancement. Use of variance discounts, risk of reversal discounts, and a first measure buffer discount provide strong integrity pillars (**Clean Energy Regulator, 2024**). Measurement integrity underpins market confidence, enhancing commercial viability, which in turn gives confidence for landholder participation. Measurement requirements of the 2021 Method is an important policy setting in place in Australia.

Funding of innovation in soil carbon measurement is another policy initiative to drive the adoption of soil carbon sequestration at scale. The Australian Government is now actively investing in innovation in soil carbon measurement (**Australian Government, 2026**). The aim of the National Soil Carbon Innovation Challenge is to improve the commercial viability of soil carbon projects by funding research and development of accurate and low-cost soil carbon measurement technologies. Funded projects include those considering technologies such as Near Infrared (NIR) spectroscopy, the use of proximal and remote sensing imagery, and advanced modelling-based approaches. These innovations encourage the adoption of soil carbon sequestration by reducing measurement costs.

Advanced modelling technologies are delivering promising results for increasing the accuracy of soil carbon measurement. This includes next-generation process-based models (for example biophysical processes like photosynthesis, microbial activity and rainfall). Use of remote sensing technologies (for example synthetic aperture ground penetrating radar), digital soil mapping to precisely map on-ground variability and enhance sampling efficiency), and the use of hyperspectral imagery (for example, focussing on plant health–related spectral regions) add powerful spatial layers (**Coelli et al., 2021; Ma et al., 2023**). Artificial neural networks (systems that flexibly integrate weightings of variables into model forecasts) and deep learning (stacking of neural networks) are bringing new intelligence to enhance the accuracy of soil organic carbon models (**Datta et al., 2024; Guo et al., 2021**).

By meeting the 2021 Method requirements, soil carbon project developers are rapidly accumulating the world’s largest soil sample databases. This data can be used to further inform innovation in measurement via calibration of models and novel measurement technologies as outlined above. This data can also inform innovation in on-farm management practices. This helps farmers to secure measured increases in soil carbon through adjusting their cropping and grazing management.

Innovative Management

Soil organic carbon levels have declined by 160 Gigatonnes (1GT = 1000 million metric tonnes) due to land management culture (**Sanderman et al., 2010**). There is an opportunity for soils to be a significant (840 GT) sink for atmospheric carbon (**Lal, 2001**). This turnaround means that different management cultures are required (**Blakemore, 2024**). The wider sustainability culture includes institutions such as Australia's Clean Energy Regulator and government policy instruments. Our home country of Australia has an established carbon offset market. These institutions, policies and incentives are beginning to be effective for farmers. Early crediting projects show that with feedback from measurement and financial incentives the on-farm cultural turnaround is possible.

Under the ACCU scheme soil carbon projects, land managers are implementing new management practices that are successfully sequestering carbon in soils. Whilst eleven 'eligible activities' are detailed in the 2021 Method, changes in management practices often involve integrating changes in these activities with normal cropping and grazing programmes. Case studies in applied science point the way to overcoming barriers to 'farmer-centric' on-farm experimentation, empowered by spatial technologies to drive improved land management (**Bramley et al., 2022**; **Song, et al., 2022a**; **Song, et al., 2022b**). A focus on measurement allows for farmer flexibility in changing management.

For example, the Howson Carbon Project in the town of Banana, Queensland has generated 9,214 ACCUs from across a 550-hectare area as part of a larger 3,745-hectare soil carbon project (**AgriProve, 2024**). Farming family the Gunthorpes manage the Howson Carbon Project. They have achieved soil carbon gains through the implementation of holistic planned grazing management, increased the number of paddocks through subdivision, and installed watering points to enable greater control of grazing intensity, timing, and longer recovery periods. They have also invested in pasture improvement with increased legumes and multi-species pastures. Remote sensing is used to monitor grazing and overall project performance. Soil carbon project design allowed spatial identification of farm areas that were successful at building soil carbon.

Similarly, the Moora Plains Carbon Project in Gogango, Queensland, generated 85,262 ACCUs across 3,553 hectares, the second-largest number of ACCUs awarded to a single soil carbon project under the ACCU Scheme (**CarbonLink, 2023**). Project landowners the Lawrie family successfully used rigorous, time-controlled planned grazing alongside increasing the number of paddocks and installation of water infrastructure, enabling greater grazing density and longer recovery periods, up to 300 days in pasture dieback-affected areas. They also improved pastures from monocultures to diverse natural pastures.

Finally, the Fife Carbon Project was issued 4,077 ACCUs across 157 hectares to become the first project in a cropping system to generate soil carbon ACCUs. This project integrates six steps to regenerate soil carbon (**LawrieCo, 2025**), which involve proprietary products to stimulate small root growth (humic acids) and enhance rhizosphere biology (including vesicular arbuscular mycorrhizae, fungi which can assist plants access scarce nutrients). These changes challenged the farmer's perception of productivity, but he is now considering living soil microorganisms and naturally occurring plant hormones and stimulants much more in his management.

It is difficult to argue in favour of any form of regenerative agriculture practice where soil conditions are in decline because of management practice. The crediting projects demonstrate an effective turnaround toward soil carbon regeneration. All three of these projects are part of commercial enterprises, and early discussions with landowners and project developers point to productivity gains. Production advantages have so far been unclear or insufficient to lead farmers to effective regeneration of soil carbon stocks at scale. Financial incentives from ACCUs can help align farmer and wider societal interest in sustaining and accelerating regeneration of soil carbon.

Monetary Incentives

Offsets play a central role as a mechanism in climate action. In this approach companies purchase offsets at a level that relates to the tonnes of carbon dioxide emitted and in accordance with accounting standards, company commitments and compliance requirements. Offsets are particularly effective because they contain two incentives, one on either side of the transaction. Companies that participate in offset markets are more ambitious and take more action to reduce emissions in their value chain (**Ecosystem Marketplace, 2023**). On the other side, offset developers are encouraged to invest in mitigation, in this case by measurably increasing soil carbon.

Offsets are also morally defensible as internalising an externalised cost. The cost of emissions is borne by the world, and imposing this cost back on the emitters activates this double incentive mechanism. Whilst these costs are likely to be passed on to consumers, it could be argued that this makes things simpler for them in the long run: Price is a more accurate reflection of the total cost of producing goods. If these impacts have been offset, consumers don't need to do additional calculations to factor in the global climate impact of their purchase. Without a requirement to offset emissions, companies do not need to consider impacts on the wider world.

In the case of soil carbon, drawing down atmospheric carbon via photosynthesis nourishes soil biology. This builds landscape productivity, resilience, and function. As soil carbon projects are implemented across Australia and the world, there will be a step-change in agricultural productivity.

Economic incentives promote the change to sustainable practices, especially in the short term (**Piñeiro et al., 2020**). Under the 2021 Method, measured Soil Organic Carbon (SOC) increases are rewarded with ACCUs, which provide these incentives. The existing market for ACCUs is external to standard agricultural markets, and this reduces farmers' risk through income diversification.

To achieve enough soil carbon sequestration to begin to counteract climate change these new management practices need to be implemented on a globally relevant scale. The most likely investment mechanism to be able to achieve this scale will be emerging Environmental Social and Governance (ESG) markets. These policy, accounting and standards arrangements could be considered cultural assets for sustainability.

In Australia, the ACCU scheme and its markets are underpinned by the Australian Safeguard Mechanism; such compliance mechanisms (requiring large emitters to buy offsets) increase market certainty for farmers and are likely to significantly enhance uptake. This ESG enhancement is a cultural asset for the carbon farming system and for society but a liability for large emitters.

Generally, there are no trade-offs between economic and environmental outcomes for farmers with soil carbon projects, and these win-win economic and environmental benefits should promote rapid uptake (**Farquhar et al., 2023: 320–40; Piñeiro et al., 2020**). Yet across Australia, soil carbon levels continue to decline due to agricultural practices despite considerable effort and a range of government initiatives to stimulate soil health. This new monetary incentive through the ACCU scheme provides a stimulus for a necessary farmer-level cultural shift. The size of this incentive programme governs the speed of action, where the higher the credit price the faster the project uptake.

Methods and Results

This paper reports on the first 34 soil carbon projects to be issued credits under the Australian ACCU Scheme. One ACCU (Australian Carbon Credit Unit) represents a tonne of carbon dioxide. In these projects, a total of 343,626 tonnes (ACCUs) were removed from the atmosphere to soil.

While these headline statistics are of interest, more detail will also provide a guide to assist farmers and advisors in assessing a business decision to embark on carbon farming. ACCUs per hectare per year is a measure of yield that can be factored into farm business models and plans. These figures will also inform researchers and innovators as to the scale of gains that are possible. This can encourage examination and optimisation of the biological processes that led to these gains.

New farming practices and sustainability cultures can be refined with experience. This special issue on Sustainability Culture led us to consider the accumulation of culture and experience in soil carbon farming. The approach developed below draws on adoption analysis using the CSIRO ADOPT model (**Farquhar et al., 2023: 324–334**). The Australian ACCU scheme project register (**Clean Energy Regulator, 2025a**) was accessed on 30 June 2025, and the full register was downloaded. The crediting soil carbon projects provided the data for ACCUs issued to soil carbon projects.

Project sampling dates are not required to be disclosed on the scheme register. Companies managing these projects were contacted for sampling dates, which were used to accurately determine over which period these ACCUs were issued for CO_2 sequestration from the atmosphere to the soil.

Shapefiles of the land area (Carbon Estimation Areas) to which these ACCUs were credited were accessed from the ACCU Scheme Project Register (**Clean Energy Regulator, 2025a**). These files enabled the calculation of areas in hectares using QGIS open-source software (**qgis.org, 2024**). This data is tabulated in Figure 2. One project, 'Grounds Keeping Carbon Project,' has had three ACCU issuances.

The area-weighted average accumulation rate (see Figure 3) is 6.0 ACCUs (tonnes) per hectare per year. The total area for the 34 projects is 16,415 hectares, and these have been issued with 343,626 ACCUs. These credits have a value more than $10M Australian dollars at a 2025 spot market price of around $35 per ACCU (**Clean Energy Regulator, 2025b**).

Figure 2: Australian ACCU Scheme Soil Carbon Projects for which ACCUs have been issued as of 30 June 2025

Project Name	Project ID	Project location	Baseline sampling date	Last sample date	ACCUs issued	CEA Area	Credits per hectare	Credits per hectare per year
Grounds Keeping Carbon Project	ERF104781	Victoria	16.12.2016	26.01.2021	3067	100	30.67	7.45
Moora Plains Soil Carbon Project	ERF105067	Queensland	10.11.2016	11.07.2021	85262	2616	32.59	6.98
Bonnie Doone Soil Carbon Project	ERF108333	Queensland	30.10.2016	29.07.2021	94666	3877	24.42	5.14
Turpentine Carbon Project	ERF102074	Queensland	22.11.2016	12.09.2021	66050	2872	23.00	4.78
Cheyenne Soil Carbon Project	ERF104527	New South Wales	09.12.2016	08.10.2021	12486	578	21.59	4.47
Smith Carbon Project	ERF158470	Queensland	12.09.2020	07.09.2022	1362	505	2.70	1.36
Fysh Carbon Project	ERF143770	Queensland	09.10.2020	14.09.2022	3559	394	9.03	4.68
Lynch Carbon Project	ERF159853	South Australia	24.11.2020	11.11.2022	641	156	4.11	2.09
McLachlan Carbon Project	ERF162497	New South Wales	08.04.2021	19.12.2022	2110	93	22.69	13.36
Swartz Carbon Project 9	ERF168650	Queensland	05.03.2022	16.03.2023	2976	177	16.81	16.32
Scully Carbon Project	ERF166967	New South Wales	17.02.2022	03.04.2023	4478	226	19.78	17.61
Swartz Carbon Project 4	ERF168644	Queensland	14.03.2022	25.04.2023	3176	148	21.46	19.24
Lazzarini Carbon Project 2	ERF167123	New South Wales	14.04.2022	26.04.2023	2234	276	8.08	7.83
Mountain View Carbon Project	ERF160172	Victoria	27.04.2022	02.05.2023	457	100	4.58	4.52
Watson Carbon Project	ERF149373	New South Wales	16.04.2020	09.05.2023	5585	268	20.84	6.80
Howson Carbon Project 14	ERF169446	Queensland	13.04.2022	30.05.2023	5623	309	18.20	16.12
Howson Carbon Project 7	ERF169439	Queensland	10.05.2022	31.05.2023	3591	250	14.36	13.58
Fife Carbon Project	ERF175975	Victoria	21.07.2022	24.07.2023	5435	158	34.49	34.20
Hodges Carbon Project	ERF175981	Victoria	07.07.2022	03.08.2023	290	132	2.20	2.05
Morrison Carbon Project 1	ERF172195	Western Australia	02.06.2022	08.08.2023	1693	184	9.20	7.77
Morrison Carbon Project 2	ERF172197	Western Australia	02.06.2022	08.08.2023	1980	109	18.10	15.29
Lyne Carbon Project	ERF154609	Queensland	07.09.2022	21.09.2023	1114	210	5.30	5.11
Howson Carbon Project 4	ERF169436	Queensland	20.04.2022	03.11.2023	5009	166	30.17	19.60
Howson Carbon Project 15	ERF169476	Queensland	13.04.2022	07.11.2023	3706	991	3.74	2.38
Lazzarini Carbon Project 3	ERF167124	New South Wales	21.03.2022	18.12.2023	4009	229	17.51	10.03
Duncan Carbon Project 2	ERF180115	Queensland	13.12.2022	20.12.2023	481	113	4.26	4.18
Barwick Carbon Project 3	ERF170334	Victoria	19.07.2022	16.01.2024	5610	248	22.59	15.10
Barwick Carbon Project 1	ERF170331	Victoria	18.07.2022	17.01.2024	3035	173	17.55	11.69
Barwick Carbon project 4	ERF170337	Victoria	17.07.2022	17.01.2024	1903	123	15.51	10.31
Killen Carbon Project	ERF173466	New South Wales	29.06.2022	31.01.2024	1711	47	36.40	22.87
Ryan Carbon Project 2	ERF179167	New South Wales	18.12.2022	05.02.2024	4839	294	16.46	14.52
Morrison Carbon Project 5	ERF172203	Western Australia	01.06.2022	17.04.2024	1484	111	13.32	7.09
Morrison Carbon Project 7	ERF172205	Western Australia	01.06.2022	17.04.2024	1495	122	12.24	6.51
Viner Carbon Project	ERF174333	Queensland	23.06.2022	20.07.2024	2509	59	42.60	20.51

Figure 3: Formula for calculation of area weighted average accumulation rate.

$$\frac{ACCU}{ha \cdot yr} = \frac{\sum_{p=1}^{n} ACCU_p}{\sum_{p=1}^{n} (a_p \cdot t_p)}$$

$where$: $ACCU_p$ *is the ACCU issuance per project*

a_p*is the issuance area in hectares of the project*

t_p *is the number of years elapsed between baseline and subsequent sampling for issuance for each crediting project p*

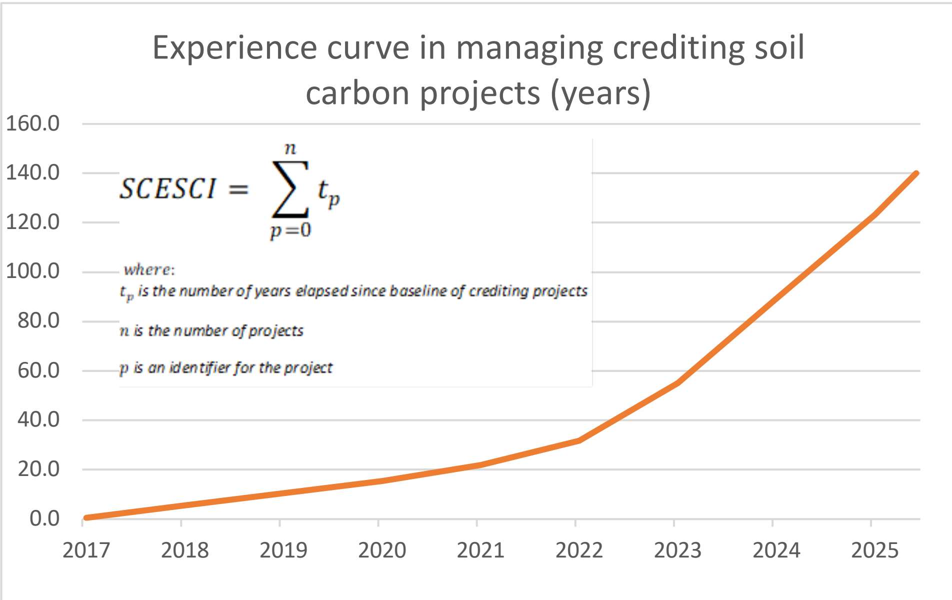
n *is the number of projects*

Figure 4: s Revenue sensitivity to ACCU price and average annual ACCU accumulation rate. The circle shows the current average ACCU price and accumulation rate of around $200 per hectare per year.

	$/ACCU															
ACCU/ha/y	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	400	1000
1	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	400	1000
2	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	800	2000
3	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	1200	3000
4	40	80	120	160	200	240	280	320	360	400	440	480	520	560	600	1600	4000
5	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	2000	5000
6	60	120	180	240	300	360	420	480	540	600	660	720	780	840	900	2400	6000
7	70	140	210	280	350	420	490	560	630	700	770	840	910	980	1050	2800	7000
8	80	160	240	320	400	480	560	640	720	800	880	960	1040	1120	1200	3200	8000
9	90	180	270	360	450	540	630	720	810	900	990	1080	1170	1260	1350	3600	9000
10	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	4000	10000
11	110	220	330	440	550	660	770	880	990	1100	1210	1320	1430	1540	1650	4400	11000
12	120	240	360	480	600	720	840	960	1080	1200	1320	1440	1560	1680	1800	4800	12000
13	130	260	390	520	650	780	910	1040	1170	1300	1430	1560	1690	1820	1950	5200	13000
14	140	280	420	560	700	840	980	1120	1260	1400	1540	1680	1820	1960	2100	5600	14000
15	150	300	450	600	750	900	1050	1200	1350	1500	1650	1800	1950	2100	2250	6000	15000
16	160	320	480	640	800	960	1120	1280	1440	1600	1760	1920	2080	2240	2400	6400	16000
17	170	340	510	680	850	1020	1190	1360	1530	1700	1870	2040	2210	2380	2550	6800	17000
18	180	360	540	720	900	1080	1260	1440	1620	1800	1980	2160	2340	2520	2700	7200	18000
19	190	380	570	760	950	1140	1330	1520	1710	1900	2090	2280	2470	2660	2850	7600	19000
20	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	8000	20000
21	210	420	630	840	1050	1260	1470	1680	1890	2100	2310	2520	2730	2940	3150	8400	21000
22	220	440	660	880	1100	1320	1540	1760	1980	2200	2420	2640	2860	3080	3300	8800	22000
23	230	460	690	920	1150	1380	1610	1840	2070	2300	2530	2760	2990	3220	3450	9200	23000
24	240	480	720	960	1200	1440	1680	1920	2160	2400	2640	2880	3120	3360	3600	9600	24000
25	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	10000	25000

The sustainability effectiveness of management culture could be considered proven when soil carbon ACCUs are issued. Figure 5 shows an accumulation curve of this Soil Carbon Effective Sustainability Culture Index (SCESCI). The chart shows accumulation to 140.1 years of SCESCI by 30 June 2025.

Figure 5: Experience curve in managing crediting projects is postulated as an indicator of the stock of sustainability culture. SCESCI is the Soil Carbon Effectiveness Sustainability Culture Index measured in years.



Discussion

SCESCI is an outcome measure of how well the world's cultures are integrating sustainable development. For high-quality soil carbon credits to be issued under the Australian scheme, many stakeholders have to 'get real and get on with it' (**Chubb, 2022**). This includes farmers, project developers, the government regulatory system, and ACCU buyers.

Measurement at the project level provides project internal integrity for soil carbon stock estimation. These measures provide clear feedback for farmers and provide assurance for purchasers of offsets. These measures as SCESCI also provide feedback on what makes for an effective culture of sustainability. To achieve the transformative changes and outcomes measured as SCESCI, three components are necessary: measurement, monetary incentives, and innovative management. Once a high-integrity soil carbon measurement and crediting system is in place, price can be a single signal to drive innovation and the adoption of an effective sustainability culture.

ESG institutions and governments can establish a dynamic price by requiring that emissions are offset. Requiring emissions offsets is a clear instrument for morally appropriate quantities required. Setting this requirement presents a clear policy for speeding action on climate change. It is clear that an integrated socioecological system is required (**Amin et al., 2020**). Lag times are measured in years as high-integrity crediting systems develop and markets align, plants grow, and farming systems adapt to build soil carbon. SCESCI targets can be the key metric for bringing forward effective transformative change. ESG markets are a cultural mechanism poised to do so, and SCESCI can be used to bring focus on effectiveness to these markets.

Conclusion

This paper is the first comprehensive presentation of soil carbon projects crediting under the Australian ACCU scheme, the first calculation of an average crediting rate, and the first presenting this data in the context of global, national, and farm-level sustainability culture. While being a complex system of measurement, policy, and land management, two simplifications of this process have emerged. First, the Soil Carbon Effective Sustainability Culture Index (SCESCI) can be a straightforward index of the effectiveness of an integrated culture at multiple scales of public interest. Secondly, once the cultural and policy infrastructure is in place, the price of carbon credits offers a clear incentive to accelerate this innovation system.

Reversing soil carbon loss is surely a cornerstone of any global Sustainability Culture. Crediting soil carbon projects are showing strong productivity gains. These observations for soil carbon are in contrast to the commonly reported trade-offs for sustainable practices (**Piñeiro et al., 2020**). The necessary cultural ingredients of measurement, innovation, and finance are brought together in soil carbon markets to enable meaningful drawdown of atmospheric carbon and regeneration of landscapes at scale.

List of Tables and Images

Duncan Farquhar is the former Chief Executive Officer of Australia's Soil Carbon Industry Group, which represents stakeholders in soil carbon as a climate solution. Duncan has an interest in the social capital underpinning natural resource management, which has been practiced in leadership roles across Australia's agricultural industries. He has a bachelor's degree in Agricultural Science and a master's degree in business administration, both from the University of Tasmania.

linkedin.com/in/duncan-farquhar

Melanie Addinsall is an agricultural policy and research and development professional with an interest in social science and structures that enable sustainable agricultural practices. She has worked in social policy with the government of Victoria, Australia; in natural resource management; and in research and innovation with AgriProve. Melanie has a bachelor's degree in environments and a master's degree in agricultural sciences and food sustainability, both from the University of Melbourne.

linkedin.com/in/melanie-addinsall-bb852150

Kieren is the General Manager of the Australian soil carbon project developer AgriProve. He holds a Bachelor of Science and a Bachelor of Arts from the University of New South Wales and a Master of Sustainability from the University of Sydney.

linkedin.com/in/kieren-whittock-b902061a4

Andrew Bremner is a strategic marketing manager at John Deere Australia. He has a bachelor's degree in engineering from Monash University and a graduate certificate in precision agriculture from the University of New England.

linkedin.com/in/ab-qld

Matthew Warnken is Founder and Chairman of AgriProve, Corporate Carbon and Foundation Co-Chair of the Soil Carbon Industry Group. He has a Bachelor of Arts and Science from the Australian National University in Natural Resource Management and Policy, a Master of Engineering from the University of Sydney and an MBA from the University of Adelaide.

linkedin.com/in/matthew-warnken

References

AgriProve, n.d. 'Howson Carbon Project'. https://agriprove.io/howson-carbon-project (last accessed 26 September 2024).

Amin, M. N., Hossain, M. S., Lobry de Bruyn, L., & Wilson, B., 2020. 'A systematic review of soil carbon management in Australia and the need for a social-ecological systems framework.' *Science of The Total Environment*, *719*, 135182. https://doi.org/10.1016/j.scitotenv.2019.135182 (last accessed 11 February 2026).

Ashworth, L. M., 2022. 'Global governance in the Anthropocenes'. *International Journal*, *77*(3), 469–484. https://doi.org/10.1177/00207020231153870 (last accessed 11 February 2026).

Australian Government. (2026, January 27). 'Improving soil carbon storage and measurement—DCCEEW'. https://www.dcceew.gov.au/climate-change/emissions-reduction/agricultural-land-sectors/soil-carbon-storage-measurement (last accessed 11 February 2026).

Australian Government Federal Registrar of Legislation, 2021. 'Carbon Credits (Carbon Farming Initiative—Estimation of Soil Organic Carbon Sequestration Using Measurement and Models) Methodology Determination 2021', F2021L01696.

Blakemore, R. J., 2024. 'Biomass Refined': 99% of Organic Carbon in Soils. *Biomass*, *4*(4), Article 4. https://www.mdpi.com/2673-8783/4/4/70 (last accessed 11 February 2026).

Bramley, R. G. V., Song, X., Colaço, A. F., Evans, K. J., & Cook, S. E., 2022. 'Did someone say "farmer-centric"? Digital tools for spatially distributed on-farm experimentation.' *Agronomy for Sustainable Development*, *42*(6), 105. https://link.springer.com/article/10.1007/s13593-022-00836-x (last accessed 11 February 2026).

CarbonLink.com, 2023. 'Case Study: Moora Plains'. 16 June. 2023. https://carbonlink.com.au/case-study/moora-plains/ (last accessed 29 January 2026).

Chubb, I., 'Carbon Farming: Let's get real and let's get on with it', 2022. Australian Government Department of Climate Change, Energy, the Environment and Water, 20 December.

Coelli, K., Karunaratne, S., Baldock, J., Ugbaje, S., Buzacotta, A., Filippi, P., Cattle, S., & Bishop, T. (2021). 'A nationally scalable approach to simulating soil organic carbon in agricultural landscapes.' Invited paper for the 24th International Congress on Modelling and Simulation (MODSIM2021), 10 December Sydney. https://doi.org/10.36334/modsim.2021.B6.coelli (last accessed 11 February 2026).

Clean Energy Regulator, 2024, September 5. 'Estimating soil organic carbon sequestration using measurement and models method.' https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme/accu-scheme-methods/estimating-soil-organic-carbon-sequestration-using-measurement-and-models-method (last accessed 11 Feb 2026).

Clean Energy Regulator, 2025, June 30. ACCU project and contract register. https://cer.gov.au/markets/reports-and-data/accu-project-and-contract-register?view=Projects (last accessed 11 February 2026).

Clean Energy Regulator (2025) 'Quarterly Carbon Market Report September quarter 2025.' Available at: https://cer.gov.au/markets/reports-and-data/quarterly-carbon-market-reports/quarterly-carbon-market-report-september-quarter-2025 (last accessed 9 February 2026).

Datta, D., Paul, M., Murshed, M., Teng, S. W., & Schmidtke, L. M., 2024. 'Unveiling Soil-Vegetation Interactions: Reflection Relationships and an Attention-Based Deep Learning Approach for Carbon Estimation'. 2024 IEEE International Conference on Multimedia and Expo Workshops (ICMEW), pages 1–6. https://doi.org/10.1109/ICMEW63481.2024.10645460 (last accessed 11 February 2026).

Dupla, X., Bonvin, E., Deluz, C., Lugassy, L., Verrecchia, E., Baveye, P. C., Grand, S., & Boivin, P., 2024. 'Are soil carbon credits empty promises? Shortcomings of current soil carbon quantification methodologies and improvement avenues'. *Soil Use and Management*, *40*(3), e13092. https://doi.org/10.1111/sum.13092 (last accessed 11 February 2026).

Ecosystem Marketplace, 2023. 'All in on climate: The role of carbon credits in corporate climate strategies', October. www.ecosystemmarketplace.com/publications/2023-em-all-in-on-climate-report/ (last accessed 8 January 2026).

Farquhar, D., Hickey, I., & Wheeler, S., 2023. 'Proceedings of the 2023 Australian Soil Carbon Industry Summit'. Soil Carbon Industry Group. https://www.scig.org.au/wp-content/uploads/2023/10/SCIG-Proceeding-of-Soil-Carbon-Summit-2023_rev4.pdf (last accessed 10 Feb 2026).

Field, K. J., Carrillo, Y., Campbell, S. A., Ton, J., & Frew, A. (2024). 'Innovation in plant and soil sciences to tackle critical global challenges.' Plants, People, Planet, 6(6), pages 1153–1158. https://doi.org/10.1002/ppp3.10520 (last accessed 11 Feb 2026).

Foster, J., 2024. 'Extractivism in the Anthropocene'. *Monthly Review*. 1 April. https://monthlyreview.org/2024/04/01/extractivism-in-the-anthropocene/ (last accessed 29 January 2026).

Fu, Q., Liu, L., & Wang, H., 2023, 'Role of fossil fuels resources on high-quality economic development: Evidence from China'. *Resources Policy*, *86*, 104126. https://doi.org/10.1016/j.resourpol.2023.104126 (last accessed 11 February 2026).

Gielen, D., & Boshell, F., 2021. 'Why renewables are the cornerstone of the energy transition'. World Economic Forum. 30 April. https://www.weforum.org/agenda/2021/04/why-renewables-are-the-cornerstone-of-the-energy-transition/ (last accessed 29 January 2026).

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R., 2019, 'The role of renewable energy in the global energy transformation'. *Energy Strategy Reviews*, *24*, 38–50. https://doi.org/10.1016/j.esr.2019.01.006 (last accessed 11 February 2026).

Görg, C., Plank, C., Wiedenhofer, D., Mayer, A., Pichler, M., Schaffartzik, A., & Krausmann, F., 2020. 'Scrutinizing the Great Acceleration: The Anthropocene and its analytic challenges for social-ecological transformations'. *The Anthropocene Review*, 7(1), 42–61. https://doi.org/10.1177/2053019619895034 (last accessed 11 February 2026).

Guo, L., Sun, X., Fu, P., Shi, T., Dang, L., Chen, Y., Linderman, M., Zhang, G., Zhang, Y., Jiang, Q., Zhang, H., & Zeng, C., 2021. 'Mapping soil organic carbon stock by hyperspectral and time-series multispectral remote sensing images in low-relief agricultural areas'. *Geoderma*, *398*, https://doi.org/10.1016/j.geoderma.2021.115118 (last accessed 11 February 2026).

Honegger, M., Michaelowa, A., & Roy, J., 2021. 'Potential implications of carbon dioxide removal for the sustainable development goals'. *Climate Policy*, 21(5), 678–698. https://doi.org/10.1080/14693062.2020.1843388 (last accessed 11 February 2026).

Jayasinghe, S. L., Thomas, D. T., Anderson, J. P., Chen, C., & Macdonald, B. C. T., 2023. 'Global Application of Regenerative Agriculture: A Review of Definitions and Assessment Approaches'. *Sustainability*, *15*(22), https://doi.org/10.3390/su152215941 (last accessed 11 February 2026).

Lal, R., 2001. 'World cropland soils as a source or sink for atmospheric carbon'. *Advances in Agronomy*, Vol. 71, 145–191). https://doi.org/10.1016/S0065-2113(01)71014-0 (last accessed 11 February 2026).

LawrieCo., 2025. 'Soil Carbon—Carbon Credits ACCUs'. https://lawrieco.com.au/soil-carbon/ (last accessed 29 January 2026).

Lehmann, J., Bossio, D. A., Kögel-Knabner, I., & Rillig, M. C., 2020. 'The concept and future prospects of soil health'. *Nature Reviews Earth & Environment*, 1(10), 544–553. https://doi.org/10.1038/s43017-020-0080-8 (last accessed 11 February 2026).

Ma, Y., Minasny, B., Viaud, V., Walter, C., Malone, B., & McBratney, A., 2023. 'Modelling the Whole Profile Soil Organic Carbon Dynamics Considering Soil Redistribution under Future Climate Change and Landscape Projections over the Lower Hunter Valley, Australia'. *Land*, 12(1), Article 1. https://doi.org/10.3390/land12010255 (last accessed 11 February 2026).

Machmuller, M., & Dillon, J., 2021. 'Regenerative Grazing, Carbon, and Climate'. *Pasture Project.* https://pastureproject.org/wp-content/uploads/2021/11/Regenerative-Grazing-and-Carbon.pdf (last accessed 29 January 2026).

Massy, C., 2020. *Call of the Reed Warbler: A New Agriculture – A New Earth*. University of Queensland Press.

Masterton, V., 2021. 'How "regenerative farming" could help reduce the impact of climate change'. *World Economic Forum,* 18 March. https://www.weforum.org/agenda/2021/03/regenerative-agriculture-revolutionize-farming-climate-cahnge/ (last accessed 29 January 2026).

McDonald, S. E., Badgery, W., Clarendon, S., Orgill, S., Sinclair, K., Meyer, R., Butchart, D. B., Eckard, R., Rowlings, D., Grace, P., Doran-Browne, N., Harden, S., Macdonald, A., Wellington, M., Pachas, A. N. A., Eisner, R., Amidy, M., & Harrison, M. T., 2023. 'Grazing management for soil carbon in Australia: A review'. *Journal of Environmental Management*, 347, https://doi.org/10.1016/j.jenvman.2023.119146 (last accessed 11 February 2026).

Oldfield, F., Barnosky, A. D., Dearing, J., Fischer-Kowalski, M., McNeill, J., Steffen, W., & Zalasiewicz, J., 2014. '*The Anthropocene Review*: Its significance, implications and the rationale for a new transdisciplinary journal'. *The Anthropocene Review*, 1(1), 3–7. https://doi.org/10.1177/2053019613500445 (last accessed 11 February 2026).

Peša, I., & Ross, C., 2021. 'Extractive industries and the environment: Production, pollution, and protest in global history'. *The Extractive Industries and Society*, *8*(4), https://doi.org/10.1016/j.exis.2021.100933 (last accessed 11 February 2026).

Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A. M., Kinengyere, A., Opazo, C. M., Owoo, N., Page, J. R., Prager, S. D., & Torero, M., 2020. 'A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes'. *Nature Sustainability*, 3(10), 809–820. https://doi.org/10.1038/s41893-020-00617-y (last accessed 11 February 2026).

QGIS, 2024, April 10. *Spatial without Compromise.* https://qgis.org/ (last accessed 11 February 2026).

Richards, G.P. and Evans, D.M.W. (2004) "Development of a carbon accounting model (FullCAM v. 1.0) for the Australian continent," *Australian Forestry*, 67(4), pp. 277–283. https://doi.org/10.1080/00049158.2004.10674947 (last accessed 11 February 2026).

Sanderman, J., Farquharson, R., & Baldock, J. (2010). 'Soil carbon sequestration potential: A review for Australian agriculture.' (p. 81) [Client Report]. CSIRO. https://doi.org/10.4225/08/58518c66c3ab1 (last accessed 11 February 2026).

Schulte, L. A., Dale, B. E., Bozzetto, S., Liebman, M., Souza, G. M., Haddad, N., Richard, T. L., Basso, B., Brown, R. C., Hilbert, J. A., & Arbuckle, J. G., 2022.

'Meeting global challenges with regenerative agriculture producing food and energy'. *Nature Sustainability*, 5(5), 384–388. https://doi.org/10.1038/s41893-021-00827-y (last accessed 11 February 2026).

Song, X., Evans, K.J., Bramley, R.G.V. et al. 'Factors influencing intention to apply spatial approaches to on-farm experimentation: insights from the Australian winegrape sector.' Agron. Sustain. Dev. 42, 96 (2022). https://doi.org/10.1007/s13593-022-00829-w (last accessed 11 February 2026).

Song, X., Evans, K. J., Kumar, S., & Bramley, R. G. V., 2022b. 'Experimentation during wine grape production in Australia: Motivations, approaches and opportunities for change'. *Australian Journal of Grape and Wine Research*, 28(1), 131–145. https://doi.org/10.1111/ajgw.12525 (last accessed 11 February 2026).

Stephens, T., 2022. 'Global ocean governance in the Anthropocene: From extractive imaginaries to planetary boundaries?' *Global Policy*, 13(S3), 76–85. https://doi.org/10.1111/1758-5899.13111 (last accessed 11 February 2026).

United Nations, 2021. United Nations Executive Office of the Secretary-General (EOSG) Policy Briefs and Papers, 'Transforming Extractive Industries for Sustainable Development', 16 June. https://doi.org/10.18356/27082245-22 (last accessed 11 February 2026).

United Nations, 2024. 'Five ways to jump-start the renewable energy transition now', 9 September. https://www.un.org/en/climatechange/raising-ambition/renewable-energy-transition (last accessed 29 January 2026).

To cite this article:

Farquhar, D., et al., 2026. 'Soil Carbon Projects: A Pathway to Sustainability, a Step Change in Global Agricultural Productivity and Meaningful Climate Action'. *Exchanges: The Interdisciplinary Research Journal*, 13(1), 93–110. Available at: https://doi.org/10.31273/eirj.v13i1.1764.
