Is carbon farming an efficient means of offsetting Australia's greenhouse gas emissions?

Carbon (C) farming is often promoted as a win-win practice for greenhouse gas (GHG) offsets and improving soil health. This view is implicit in the Australian Government's Carbon Farming Initiative (CFI) of the current Emissions Reduction Fund (ERF). However, claims made at the national level for C sequestration potential in the landscape, and at the farm level for C in soil, cannot be substantiated when compared with scientific evidence of measured rates of C accumulation in Australia and overseas. Nor has the cost-effectiveness of sequestering soil C under the CFI and ERF been analysed at the national or farm level. As it stands, the CFI is a subsidy to farmers and should be recognised as such. Until these questions are resolved, implementation of the policy is economically irresponsible and runs the risk of diverting resources from other sectors where significant reductions in GHG emissions could be achieved.

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Introduction

Carbon farming is shorthand for sequestering carbon (C) in the landscape – in above ground vegetation and in soil organic matter (SOM). Above ground vegetation traps carbon dioxide (CO_2) by photosynthesis, but the global amount of C trapped is small compared to that stored in SOM, estimated to be 1500 billion (B) tonnes (t) C to 1 metre depth (Paustian et al. 2019). To a varying extent and on different time scales, CO_2 in the atmosphere cycles through soil C via the return of plant and animal remains and excreta.

In Australia, the vulnerability of vegetation C to loss by fire makes it problematic as a permanent (at least 100 years) store of C. Hence, sequestering C in soil is an attractive option for policy-makers and those who influence policy, because it appears as a cheap and effective method of offsetting greenhouse gas (GHG) emissions. It is referred to as a method of achieving negative emissions. This is one of the reasons the Commonwealth Government created the Carbon Farming Initiative (CFI) in 2011, subsequently absorbed into the Emissions Reduction Fund (ERF), whereby landholders receive payments in C credits for successfully sequestering C in soil and other reserves. Carbon farming is often claimed to be a win-win practice because not only are GHGs offset, but the increase in SOM is also of benefit for soil health and crop productivity.

In this article we identify the biophysical and financial limitations associated with some of the claims made for C sequestration, with particular reference to the soil. In consequence, we reveal flaws in the formulation and implementation of C farming policy, both nationally and locally, which can undermine Australia's credibility in accounting for GHG emissions and their offsets.

The Garnaut hypothesis

In his new book called *Superpower*, Ross Garnaut (2019) writes of the 'immense potential for storing carbon in the [Australian] landscape'. He compares the C sequestration potential of our landscape to that of the United States at 1 gigatonne (Gt) of carbon per annum (p. 142). This amounts to the absorption of 3.67 Gt carbon dioxide equivalent (CO_2-e) per annum. Semi-arid rangelands are the largest single land use in Australia at 455 million (M) ha. For this area, Garnaut estimated that 250 Mt CO_2-e per annum could be sequestered, amounting to an average annual rate 0.55 t CO_2-e/ha. However, the CFI Carbon Mapping Tool (2015) showed that most of the Australian landmass has no sequestration potential at all, and that which is of marginal potential can sequester at only 0.07 to 0.59 t CO_2-e/ha/ year. Given these figures, the remaining 297 M ha (excluding urban areas) must sequester 3.42 Gt CO_2-e per year, which is equivalent to a rate of 11.5 t CO_2-e/ha/year. This is an extremely high rate when one considers that Sanderman et al. (2010) concluded that the potential for Australian agricultural land (approximately 92 M ha) was between 0.3 and 0.6 t C/ha/year, or 1.1 to 2.2 t CO_2-e/ha/year. From a review of 126 studies on grassland improvement worldwide, Conant et al. (2017) reported an average increase of 0.47 t C/ha/year (1.72 t CO_2-e/ha/year), which is within the range reported by Sanderman et al. (ibid.).

Garnaut's hypothesis could lead policy-makers to conclude that there was a much larger potential for vegetation and soil sequestration of C than was realistic.

If the potential of rangeland and agricultural land is so low, production forestry and native woodlands and scrub must sequester C at a very high rate, which may be possible for young plantations growing rapidly in high rainfall areas, but not more widely as seen from the figures Garnaut quotes for brigalow and mulga on p. 152. Clearly, Garnaut's hypothesis could lead policy-makers to conclude that there was a much larger potential for vegetation and soil sequestration of C than was realistic.

Carbon sequestration at farm level

In May 2019, Oli Madgett reported in the *Australian and New Zealand Grapegrower and Winemaker* that the Olsen farm in Gippsland had been awarded 407 Australian Carbon Credit Units (ACCUs) for soil C stored on 100 ha following pasture renovation, said to be the first ACCUs issued to a farmer under the ERF. This was followed by Sue Neales in *AgJournal,* in November 2019 reporting on the same farmer's feat of 'building stored carbon at the rate of 11.3 tonnes per hectare in the first year across 100 hectares'. This is amounts to an incredible 41.5 t CO_2-e/ha/year. Unfortunately, this report was misleading because the figure was actually 12.2 t CO_2-e/ha (i.e. 3.32 t C/ha), measured to a depth of 1 m (AgriProve, personal communication). This figure would be inflated due to the 1 m depth of sampling, since nearly all reported data for C sequestration is based on a 30 cm depth, as required under the original Kyoto protocol.

According to the list of projects on the Clean Energy Regulator's (CER) website,[1] the Gippsland project (ERF 104781) was first registered in October 2016, under CFI Methodology Determination 2014, and was actually awarded 406 ACCUs in 2019. The awarding of 406 ACCUs for 100 ha of farmland means that 4.06 t CO_2-e/ha were sequestered. However, under the CFI rules, C credits are discounted by 50% in the early days of a project, until such time as a long-term trend in C accumulation is established (Paustian et al., ibid.). This implies that some 8 t CO_2-e/ha/year were deemed to have been sequestered in this project. Although this figure is much below that misquoted by Neales, it is still much larger than the C sequestration figures cited by Sanderman et al. (ibid.) and Conant et al. (ibid.) mentioned above.

The questions arising are first whether the rate of 11.2 t CO_2-e/ha in one year can be sustained for 25 years (the minimum permanence period), and second, if so, what is the unusual mechanism by which this has been achieved that seems contrary to established scientific evidence (White et al., 2018)? These questions need to be resolved if the Australian Government is to pursue soil C sequestration as an internationally credible means of offsetting the nation's GHG emissions in the longer term.

1 www.cleanenergyregulator.gov.au

The cost-effectiveness of a policy to use soil C sequestration as an offset for GHG emissions

The true costs of change

To achieve the overall aim of sequestering C in soil requires a significant number of compliant landholders, all working towards the same objective. It is reasonable to assume that current landholders are already undertaking actions that are profitable to them to improve soil organic C on their farms. The wide adoption of minimum and no-till cultivation is an example of practices that are beneficial both from an economic and soil health perspective. Any further actions by landholders to improve soil C will come at a cost in the form of the higher transactions costs of implementing new practices, and/or losses associated with the new and different enterprises.

White and Davidson (2016) assessed a range of approaches to sequestering soil C, including intensification, stubble retention and conversion from cropping to pasture. They concluded that the only acceptable measures were both expensive and relatively ineffective since the net abatement of 2.84 Mt CO_2-e (i.e. only 0.52% of the annual Australian GHG emissions at that time) would cost the government approximately $35 M. They did not assess the alternative and possibly more costly measures suggested by Garnaut (ibid.) and others (see Niall Blair below), of revegetating mallee and brigalow rangelands or agroforestry.

In addition to the costs incurred by individual landholders, system-wide costs also need to be accounted for. For instance, increasing woody vegetation may affect run-off into rivers, reducing their flow and resulting in less water available for irrigation. All landscapes require management, even those allowed to revegetate back to their natural state. There is a cost imposed on rural towns as enterprises change. All these costs need to be accounted for if the true cost of C sequestration is to be assessed.

Problems of measuring carbon in soil

More importantly, the cost of measuring the change in soil C itself has not been factored into the calculations. The cost of measuring a change in soil C with reasonable certainty are significant at approximately $44/ha, which is more than the value of one ACCU a farmer could earn from the test. These tests need to be conducted regularly if C sequestration is to be validated and carbon credits are to be paid. Because of this problem, and also the limited range of farming systems that could participate, the number of soil C projects taken up under the CFI has been few (see the CER's website). The approved methodology has changed three times since the inception of the CFI, evolving from 'Sequestering carbon in soils in grazing systems' (measurement based) to 'Estimating sequestration of C in soil using default values' (model based) to 'Measurement of soil carbon sequestration in agricultural systems 2018'. The last-mentioned method combines elements of the earlier iterations and seeks to simplify the scheme to encourage more participants (Paustian et al., ibid.).

So far, the measurement problem means that it is impossible to determine the technical efficiency parameters required to achieve meaningful sequestration of soil C. Without these, an outcome that is economically efficient cannot be determined; hence the most cost-effective way of sequestering soil C cannot be identified. Nevertheless, we expect that technological developments in proximal sensing will improve the accuracy of measurement at reduced cost, although it is unknown how far off such a cost-effective test is.

Other problems with carbon farming

Stories exist of landholders in marginal areas, who have a permit to clear land from a state government (as, for example, in western New South Wales), applying under the CFI for carbon credits for surrendering the right to clear that land. Clearly, if true, such actions are a cost to the ERF and more importantly, do not result in any real change in the national GHG emissions. Recently, the Minister for Agriculture, Drought and Emergency Management was reported (Higgins, 2020) as telling an ABARES Outlook Conference that speculators were buying land in Queensland with no intention of farming productively, but rather claiming C credits for allowing natural revegetation (*The Australian*, 4 March).

Professor Niall Blair recently argued in *The Age* (25 February) that for those who:

> "... have been crying out for government to increase subsidies for farmers ... this is your chance. We could unlock billions of dollars from government and industry funds, paid directly to farmers to help improve their natural capital, their soil, vegetation and farming practices – not to mention innovation and research – which, in turn, will reverse the effects of climate change."

Whether this is the best use of the money, or even if an alternative exists, is not questioned because this is seen as an opportunity to subsidise agriculture.

Subsidies of one form or another already exist in agriculture to encourage C sequestration. After all, that is what the ERF provides. However, the value of an ACCU has been too low to promote any significant uptake and would need to increase substantially to encourage more participation. Large subsidies in situations where the measurement of impact is difficult (possibly impossible) are certainly dubious and easy to rort.

Additionally, subsidies have a distortionary impact. Without a C market, the question arises as to whether the subsidies themselves and the resulting distortions are worthwhile. The distortions that are most worrying are those that may result in GHG emission reductions in other areas not being undertaken. Inflated claims of the amount of C sequestered in the landscape may lead to less attention paid to the energy and transport sectors where more effective policies could well be applied. This leads to another insidious impact of the CFI policy – the international reporting of emissions. How can the nation report with credibility on reductions in emissions if they cannot be reliably measured?

Conclusions

Until a cost-effective test is developed, governments paying to encourage more soil C exposes three significant risks.

a. Society could pay too much for a practice that may not only be inefficient but may also be ineffective. Of course, it may become more effective in time, but this is not yet known.

b. Carbon sequestration may well be seen as the panacea for addressing many of the nation's problems with GHG emissions, resulting in more effective actions in other sectors being ignored.

c. If governments become involved and implement policies to promote C sequestration, they could both encourage rorting and claim credit for results that cannot be validated.

If the arguments presented above are not compelling enough, it should be remembered that Australia has followed a similar path in the past in respect of the National Action Plan on Salinity (NAPS). Between 2000 and 2010 the concern was with salinity and rising water tables, especially in Western Australia. The solution to this complex problem was to revegetate with deep-rooted species and improve drainage. Pannell and Roberts (2010) and the Auditor General (2008) concluded that the massive expense ($1.4 billion) was not worth it. The Auditor General (2008, pp. 19–20) found that 'Where the impact on resource conditions is identified by regional bodies, the expected results were often low (frequently less than one per cent of the longer-term resource condition target)'. Pannell and Roberts (ibid.) outlined a number of criteria that would need to be met if other similar programs were to be attempted, including many associated with measuring impacts and assessing the economic viability of both projects and measures.

Whereas measuring salinity and rising water tables is much easier and more transparent than measuring C sequestration, the extent of failure in the CFI could well be more substantial than that associated with the NAPS. The questions arise – have the various C sequestration schemes been tested against the criteria developed by Pannell and Roberts (ibid.)? Can the impacts of a policy for C sequestration even be measured? Are the effects stated by proponents physically achievable?

Can the impacts of a policy for C sequestration even be measured?

The case for Australia pursuing the policy and practices of C farming, particularly with respect to soil, is not as compelling as those who advocate for it would make out. All the (questionable) arguments in favour are based on the size of the Australian landmass and the apparent ease of implementation, not on its economic viability. Even the physical elements of the argument are dubious, given the measurement problems for soil C, the paucity and unreliability of Australian rainfall for growing vegetation and the ravages of bushfires. The economic and political ramifications of widespread adoption of C farming have not been debated. Yet, despite the limitations and the unknowns, C sequestration is promoted as an 'opportunity' that the nation should not forego. Until the physical measurement problems are solved and the economic efficiency considerations are thought through, government action in funding the implementation of this policy is irresponsible.

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