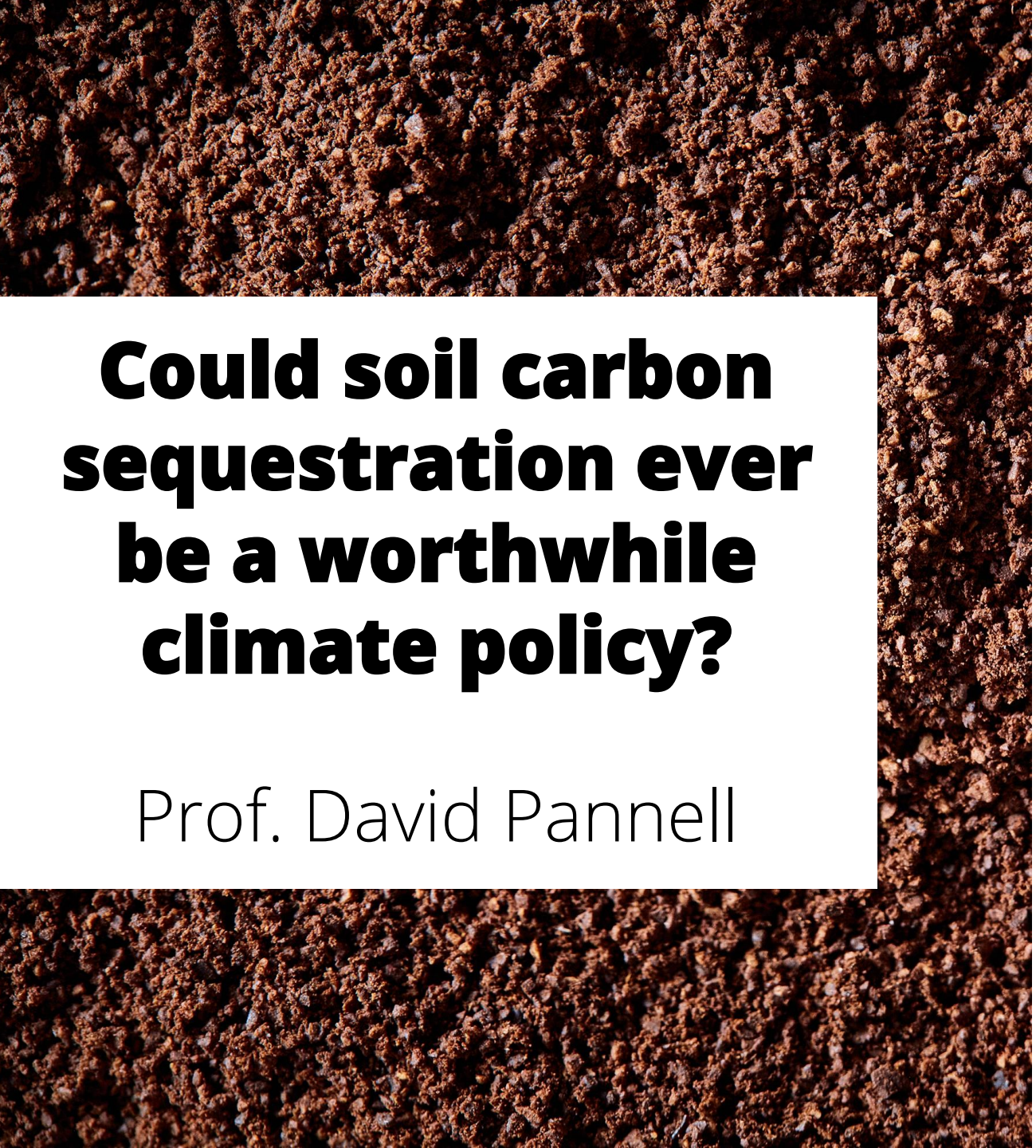

Could soil carbon sequestration ever be a worthwhile climate policy?

Prof. David Pannell

The 2022

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Could soil carbon sequestration ever be a worthwhile climate policy?

David Pannell
Centre for Environmental Economics and Policy

Pannell, D. and Crawford, M. (2022). Challenges in making soil-carbon sequestration a worthwhile policy, *Farm Policy Journal*, Autumn 2022.

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Challenges in making soil-carbon sequestration a worthwhile policy

Creating financial policy mechanisms that encourage farmers to sequester carbon in agricultural soils is widely seen as a useful policy response to combatting climate change. However, there are a number of challenges that make it difficult for such an approach to be effective and worthwhile. If a policy accounts well for the realistic technical complexities of soil-carbon sequestration, the revenues received by farmers will be small relative to their other costs and revenues, and so will make little difference to their decisions about farming practices. There is a high risk of paying farmers for doing things that they would have done anyway, despite existing policy measures intended to avoid this. Even if the current high cost of measuring soil carbon can be substantially reduced, this will not be sufficient to overcome the other technical and economic challenges that reduce benefits and limit participation in the offset program by farmers. Targeted agricultural research and development may help to overcome some of these challenges.

David Pannell
University of Western Australia

Michael Crawford
CRC for High Performance Soils

The same piece of land does not continue to offset new emissions indefinitely.

Soil carbon features in the Australian Government's 2021 "Long-Term Emissions Reduction Plan" and has been advocated by politicians and others as a strategy to help address climate change. The Government hopes that soil carbon can make a major contribution to achieving a target of net zero emissions by 2050. To that end, it released a "Low Emissions Technology Investment Roadmap" in 2020 identifying reducing the cost of soil carbon measurement as a priority technology to help stimulate more soil-carbon sequestration activity.

In December 2021, the Minister for Industry, Energy and Emissions Reduction put into effect a new "Methodology Determination" for soil carbon, defining what farming activities can be undertaken and how their carbon sequestration will be measured.[1]

Prominent economist Ross Garnaut is also enthusiastic about the prospects for soil carbon. In his 2019 book *Superpower: Australia's Low Carbon Opportunity*, he says "Australia can make an exceptional contribution to climate action by creating natural systems to store more carbon in soils".

Unfortunately, there are aspects of the science and economics of sequestering soil carbon that pose enormous challenges to achieving such an outcome, and there are additional challenges specific to the design and implementation of an effective soil-carbon policy that reduce the likely benefits of any such policy.

Limited potential gains

It is difficult to increase the amount of carbon stored in most cropped soils in Australia. Australian soils, climate and farming systems don't lend themselves to storing great amounts of carbon. A wide-ranging assessment of soil organic carbon levels in Australia last decade showed that the major drivers of carbon stocks were rainfall and soil type, with management making a minor contribution. Australian crop growers have for decades been practising methods advocated for improving soil carbon (e.g. no-till and stubble retention) and soil carbon levels have not changed all that much (Metcalfe & Bui 2016).

In addition, even if soil carbon can be increased, soil-carbon sequestration on a piece of farm land is a one-time event. Once a new farming system is adopted, soil carbon increases for about 20–30 years and then stops increasing as a new equilibrium is achieved. The same piece of land does not continue to offset new emissions indefinitely. However, farmers need to stick with the new management regime to avoid releasing the carbon they have sequestered, so costs continue to be incurred, but not new benefits that would justify further payments.

Sequestration increases other emissions

The 2021 Methodology Determination mentioned above lists various farming practices that may contribute to increasing soil carbon. One that potentially makes a relatively large difference to soil carbon is converting land from crop production to permanent perennial pastures. However, for a farmer looking at this option, there are trade-offs when the whole system is considered. Not only would switching to perennial pastures be substantially less profitable for many crop farmers – potentially a far greater drop in profit than can be compensated for by any plausible carbon offset payment – but it may not decrease emissions overall, at least with current technologies. Farmers use pastures to run livestock, and methane emissions from livestock would negate some or all of the gains in soil carbon. Australian research has shown that if farmers switch from cropping to permanent pasture, grazed by livestock, the net effect on greenhouse gases when increased methane emissions are accounted for is close to zero (Meier et al. 2020). The new soil carbon Methodology does provide for deductions due to extra emissions that occur as a result of adopting the new practices, so that means that the offset payments to crop farmers who switch to perennial pastures

1 https://www.legislation.gov.au/Details/F2021L01696

Michael Crawford is Chief Executive Officer of the CRC for High Performance Soils. PhD in soil organic carbon.

Australia's plan includes soil carbon

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- *"landholders could earn around $400 million in additional revenue through the sale of accredited soil carbon sequestration in 2050"*

It’s included in Technology Roadmap

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- Aim: reduce cost of measuring soil carbon from $30 per hectare per year to under $3
- A “stretch target”

There is a new “method” for soil carbon

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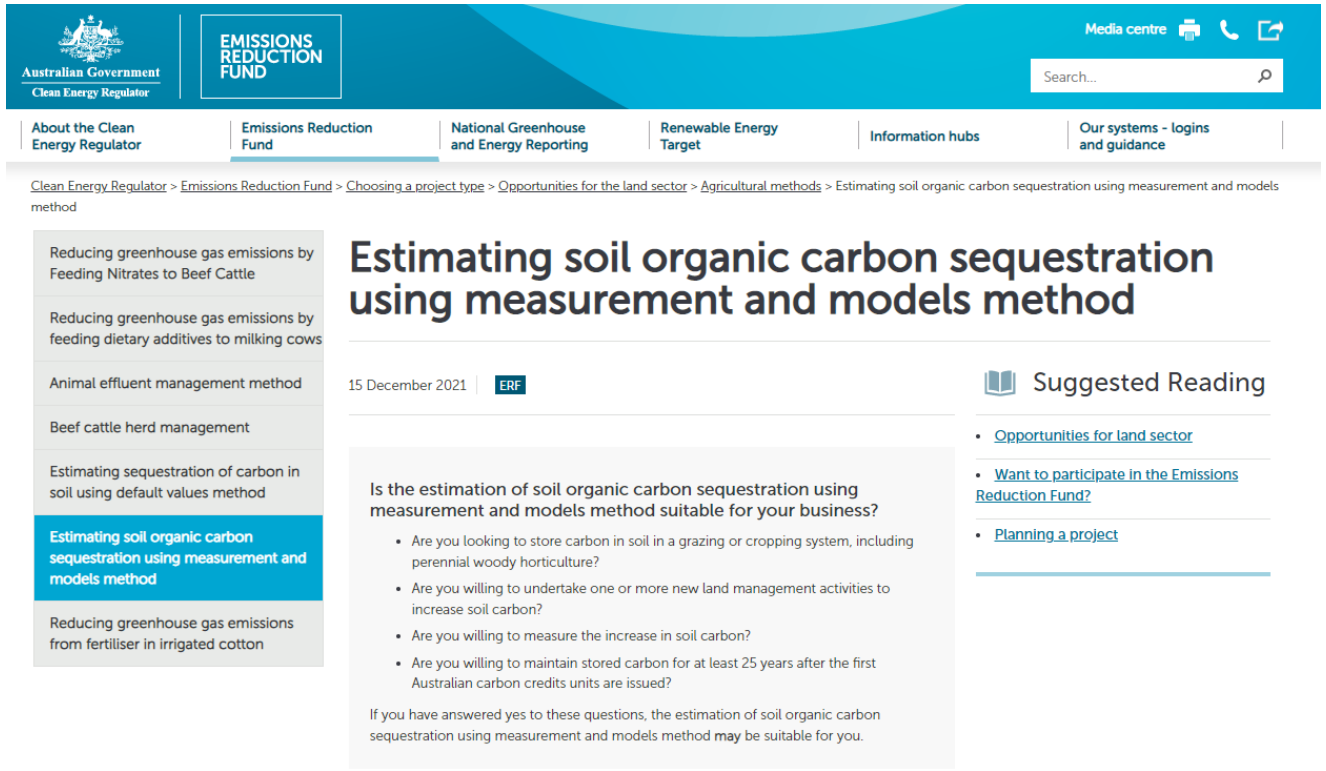
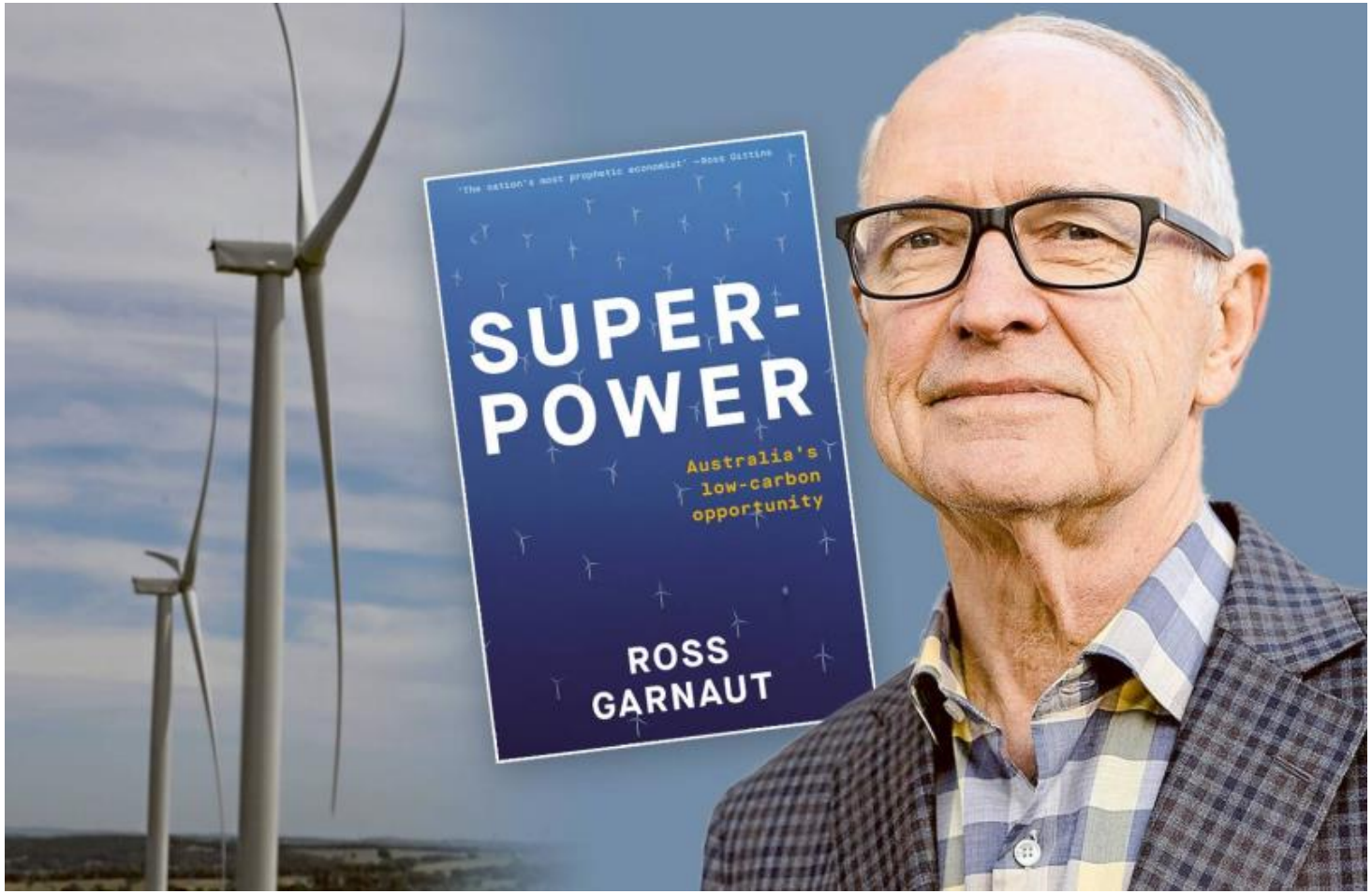


Practices that can earn payments

(i) applying fertiliser
(ii) applying lime to remediate acid soils
(iii) applying gypsum to manage sodic soils
(iv) undertaking new irrigation
(v) re-establishing or rejuvenating a pasture
(vi) switching from cropland to permanent pasture
(vii) grazing management for soil vegetation cover
(viii) retaining stubble after harvest
(ix) reduced or no tillage practices
(x) controlled traffic, deep ripping, water ponding
(xi) clay delving, clay spreading, inversion tillage
(xii) using legumes in cropping or pasture
(xiii) cover crops to promote soil vegetation cover

Ross Garnaut is positive

- *"Australia can make an exceptional contribution to climate action by creating natural systems to store more carbon in soils"*



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There is a growing support industry

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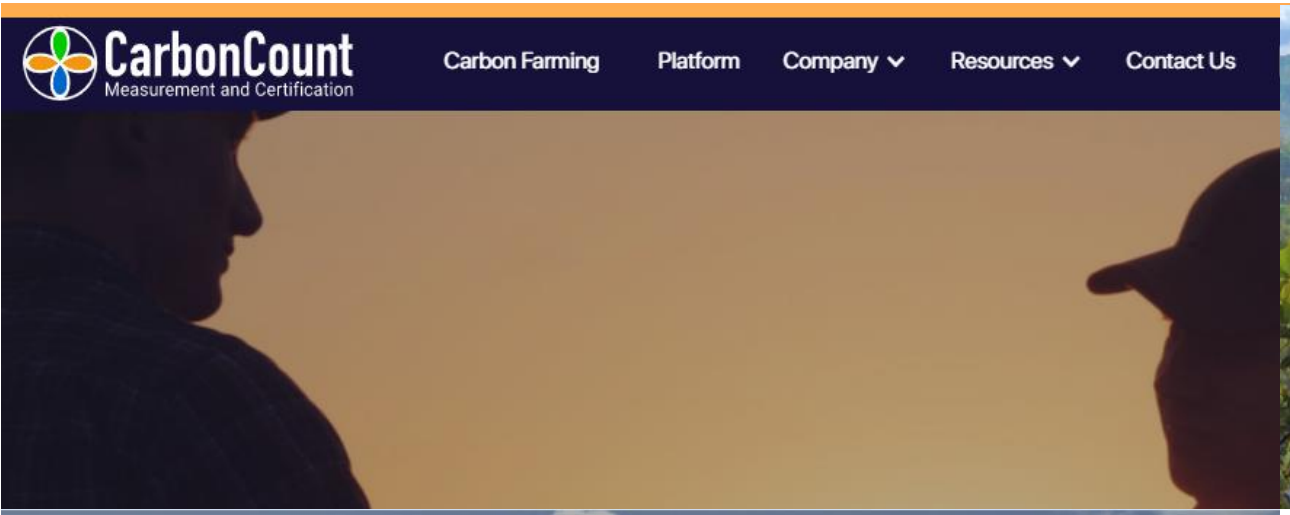

And much media coverage

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ABC NEWS

Carbon soil projects pivotal in government's net zero plan, but market progress 'slow'

Landline / By national rural reporter Kath Sullivan
Posted Wed 10 Nov 2021 at 4:26am

STOCK & LAND

The dawn of soil carbon farming in Australia

Politics Federal Emissions

The Sydney Morning Herald

Looming soil carbon policy could disadvantage the best farmers

By Mike Foley
February 15, 2021 — 6.16pm

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Farmers poised to cash in on net zero: Littleproud

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Soil carbon: what role can it play in reducing Australia's emissions?

We break down the facts around one of the Coalition's five priority areas in its 'technology, not taxes' response to the climate crisis

It looks easy

- Measure current soil carbon
- Adopt one of the 13 eligible practices
- Measure the increase in soil carbon
- Wait for the cheque

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But … reservations expressed by experts

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scientific reports

Open Access | Published: 12 July 2013

The potential for carbon sequestration in Australian agricultural soils is technically and economically limited

Shu Kee Lam, Deli Chen, Arvin R. Mosier & Richard Roush

PNAS

Soil carbon sequestration is an elusive climate mitigation tool

Ronald Amundson[a,1] and Léopold Biardeau[b]

The need to stabilize the greenhouse gas concentrations of the atmosphere is the great environmental challenge of this century. To control these concentrations, humanity can reduce fossil fuel emissions and/or alternate way to help stem the rate of greenhouse gas growth and associated changes in our climate.

For nearly 2 decades, researchers in the soil science community have studied and estimated the potential of

soil systems

MDPI

Review

The Role of Soil Carbon Sequestration as a Climate Change Mitigation Strategy: An Australian Case Study

Robert E. White

Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Melbourne, VIC 3010, Australia; robertew@unimelb.edu.au

National Research FLAGSHIPS
Sustainable Agriculture

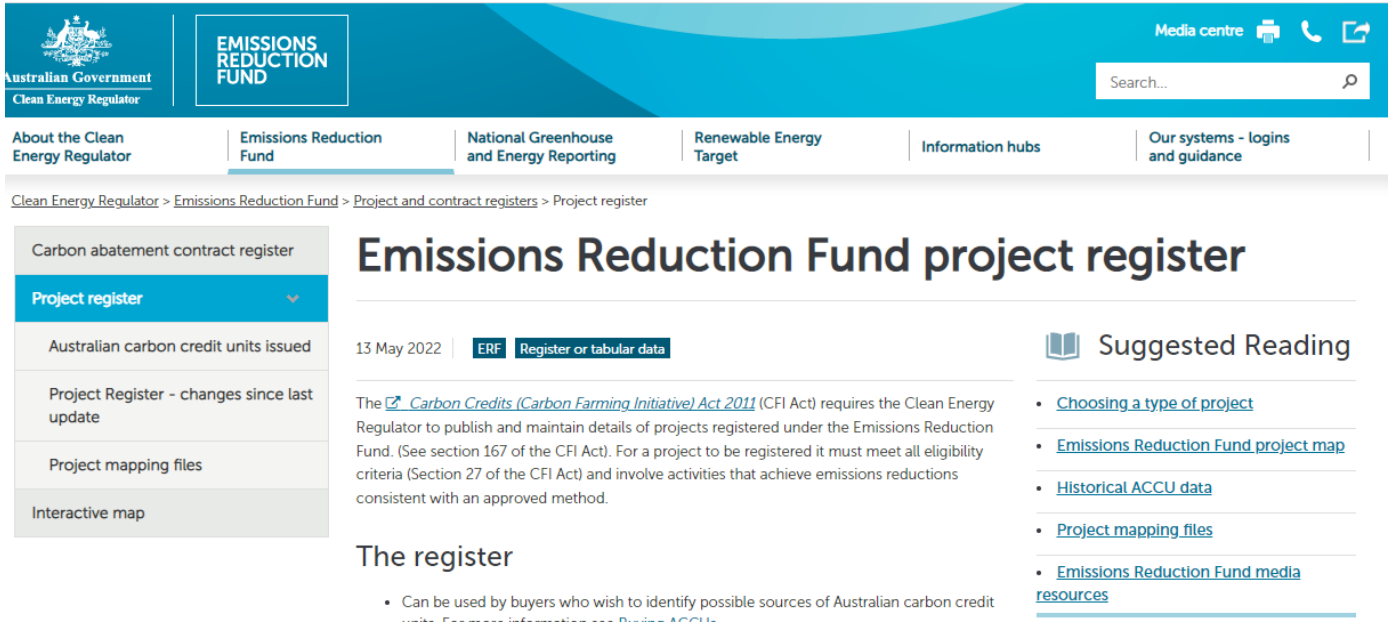
CSIRO

Soil Carbon Sequestration Potential: A review for Australian agriculture

Jonathan Sanderman, Ryan Farquharson and Jeffrey Baldock
CSIRO Land and Water

Low participation so far

- ERF started in December 2014
- 177 soil carbon projects registered (1 in 500 farmers)
- 5 projects contracted
- 1 has been awarded ACCUs



Various challenges

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- Technical
- Economic
- Information
- Policy design

Questions

- Can paying farmers to sequester C contribute to mitigation?
- Is it a cost-effective approach?

Limited potential gains

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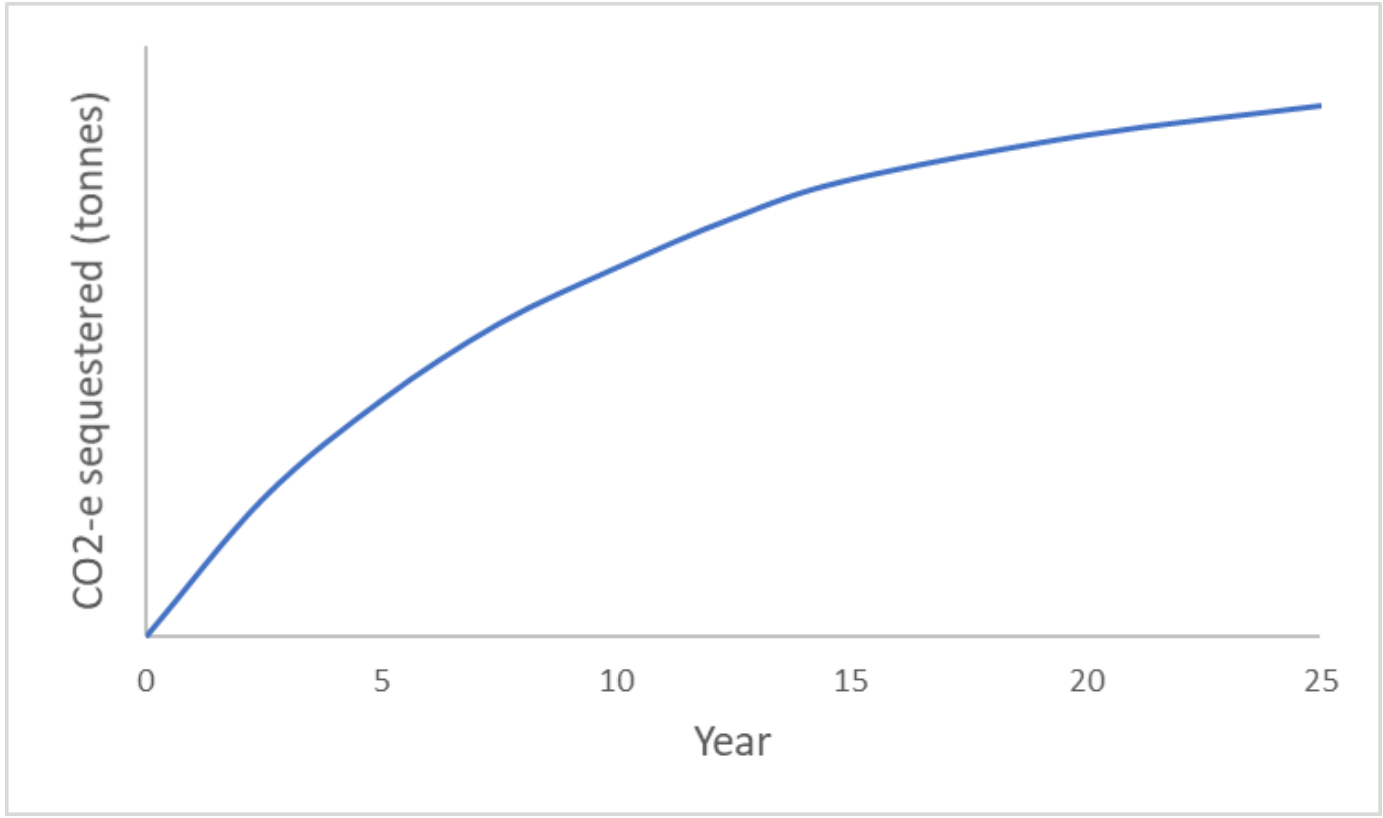
- The major drivers of carbon stocks are rainfall and soil type
- Management makes minor contribution
- Measured gains are mostly small
- *"I tried (and failed) for 30 years on my farm to lift soil carbon levels."*
  (NSW cotton farmer)

New sequestration falls over time

- Soil carbon converges on new equilibrium over a few decades
- New sequestration falls over time



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Deductions for reversal and impermanence

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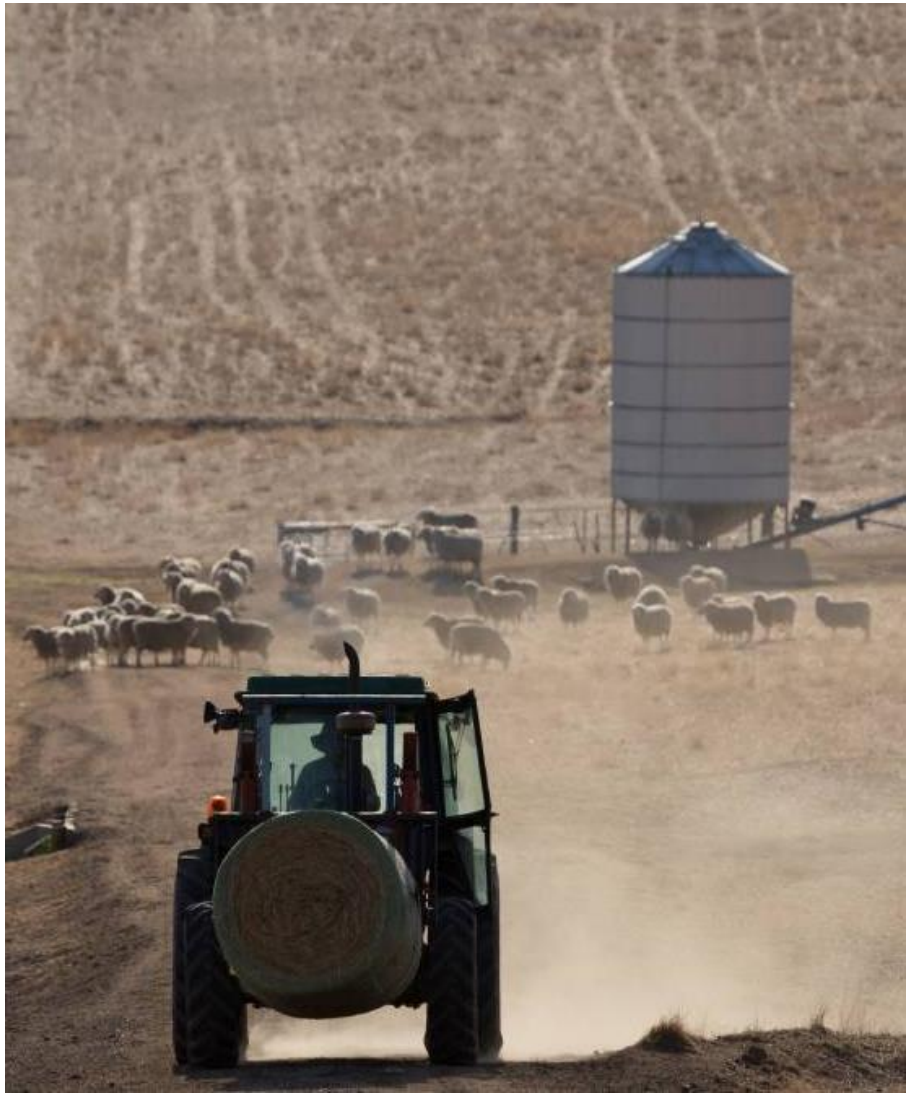
- Risk of reversal (e.g. drought)
  - Deduction of 5%
- Impermanence (25 years, not 100)
  - Deduction of 20%



Deductions for increases in emissions

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- Crop → permanent pasture
  - ↑ soil carbon
  - ↑ methane emissions from livestock
  - Losses roughly cancel out gains
    (Meier et al. 2020)
  - Not attractive to most croppers anyway
- Improve pasture productivity
  - Similar pattern but less extreme

Meier et al. (2020). Greenhouse gas emissions from cropping and grazed pastures are similar: a simulation analysis in Australia. *Frontiers in Sustainable Food Systems* 3, paper 121.

Deductions for increases in emissions

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- Higher soil carbon ↑ conversion of N fertilizer to nitrous oxide gas
- N_2O 300 times more potent than CO_2
- *"in only a few cases did the increase in soil C storage counter the N_2O emissions sufficiently to provide net greenhouse gas abatement."*
  (Palmer et al. 2017)
- Soil C sequestration decreases over time but N_2O emissions continue
  (Palmer et al. 2017)

Palmer et al. (2017). Management practices likely to provide greenhouse gas abatement in grain farms in New South Wales, Australia. *Crop and Pasture Science* 68, 390–400.

Other costs of being in the program

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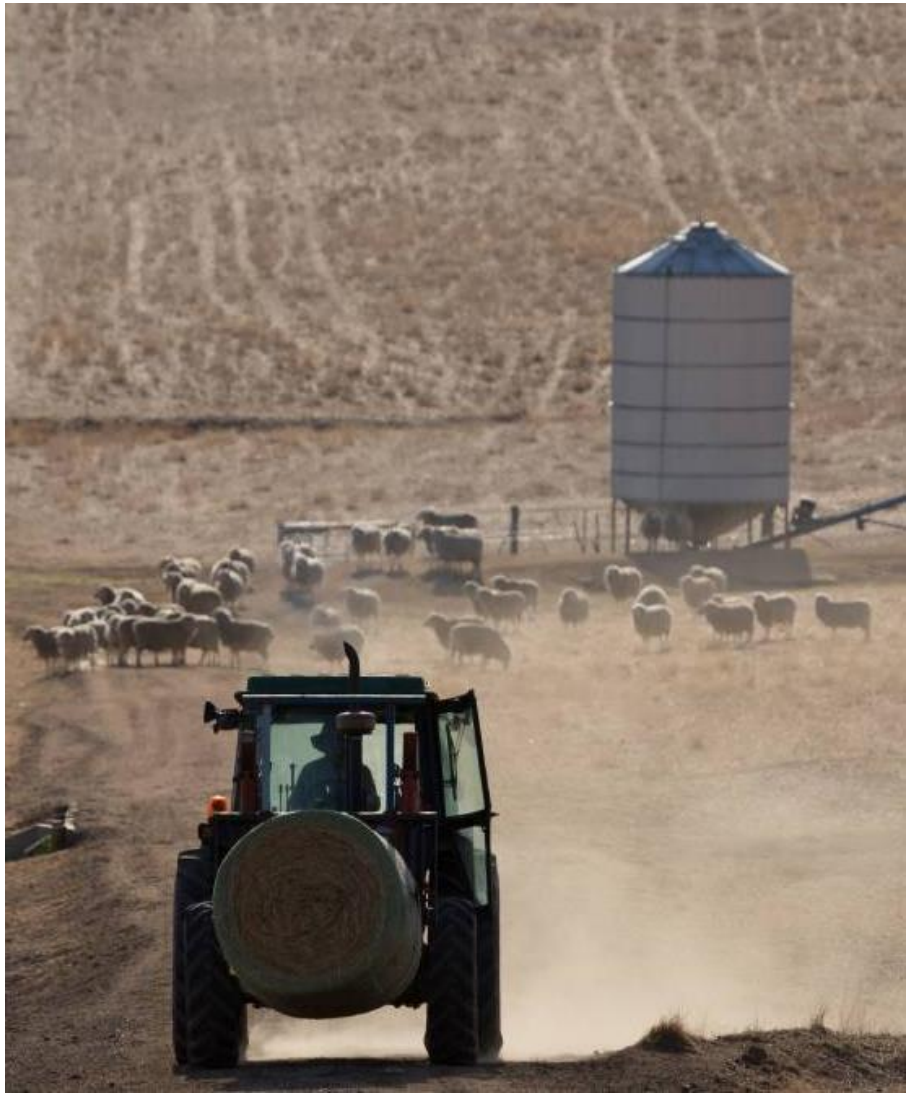
- Paperwork
- Establishing baseline
- Measuring soil carbon level over time

- Inflexibility – must stick with new practices for 25 years



Another cost: replacing plant nutrients

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- Some C in soil is humus (~50% in WA)
- Relatively stable
- Process of forming humus ties up other nutrients (N, P, K and S) that would otherwise be available to plants
- Replacing these costs money

Farmers benefits and costs

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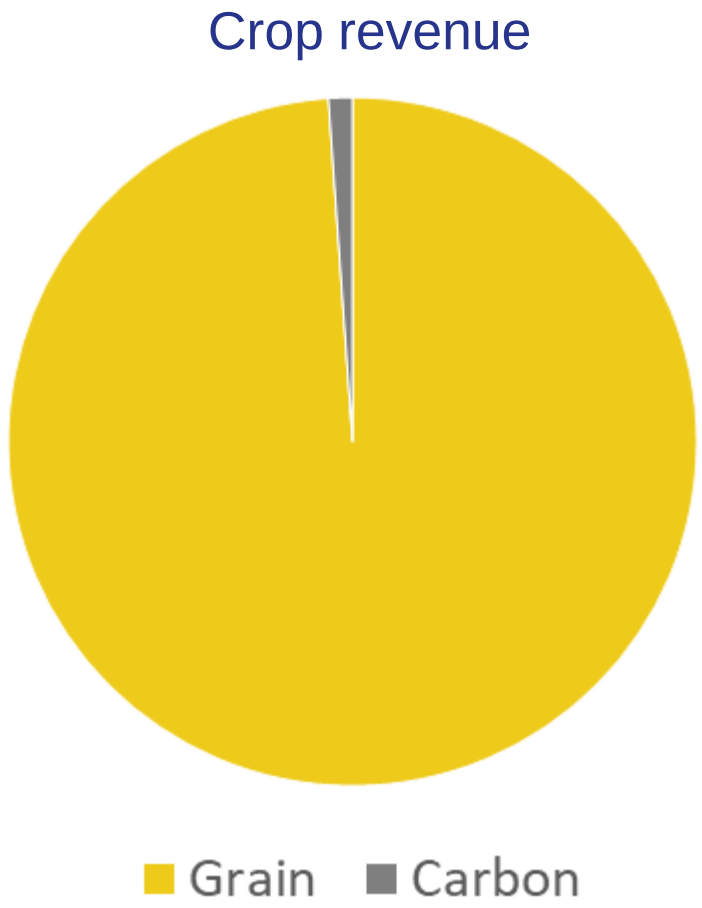
- Crop soils sequester 0.0 to 0.73 tonnes CO_2-e per ha per year e.g. $25/tonne x 0.37 = $9/ha/year
- New sequestration falls over time
- Minus 5% deduction for risk of reversal
- Minus 20% deduction for impermanence
- Minus deductions for other emissions
- Minus cost of soil testing ($3+), reporting, auditing
- Minus cost of inflexibility

Net benefit of program participation

- Minus cost of tying up other nutrients
- Minus cost of doing new practice
- Plus benefits of new practice (other than C seq)

Net benefit of practice

Some numbers updated since the webinar



2.5 tonne wheat crop at $326/tonne farm-gate price

Benefit to farmers of participation

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	Crop	Crop	Pasture	Pasture
Price of CO2-e ($/tonne)	$25	$50	$25	$50
Initial sequestration (tonne/ha/year)	0.37	0.37	1.5	1.5
Average sequestration relative to initial sequestration (proportion)	0.5	0.5	0.6	0.6
Deduction for risk of reversal	0.05	0.05	0.05	0.05
Deduction for impermanence	0.2	0.2	0.2	0.2
Deduction for other emissions (proportion of initial seq)	0.065	0.065	0.035	0.035
Cost of soil testing, reporting, auditing ($/ha/year)	$16-$4	$16-$4	$16-$4	$16-$4
Cost of inflexibility ($/ha/year)	$1	$1	$1	$1
Benefit of participation in ERF ($/ha/year)	**-$4**	**-$2**	**$7**	**$16**

Lower cost of measuring does not solve problem

Some numbers updated since the webinar

Implications for farmers

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- Don’t expect big money from ERF for soil C
- Especially not croppers
- Slightly better prospects for livestock producers

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What carbon farming activities are farmers likely to adopt? A best–worst scaling survey

Nikki P. Dumbrell[a,*], Marit E. Kragt[a,b,c], Fiona L. Gibson[a,b]

[a] Centre for Environmental Economics and Policy, School of Agricultural and Resource Economics, The University of Western Australia, Crawley, WA, Australia
[b] Australian Research Council Centre of Excellence for Environmental Decisions, The University of Western Australia, Crawley, WA, Australia
[c] Agriculture Flagship, Commonwealth Scientific Industrial Research Organisation (CSIRO), Perth, WA, Australia

- *"the opportunity to generate carbon credits was not an important driver to adopt carbon farming practices … [practices] are most likely to be adopted as a result of the private benefits they can provide."*

Additionality (benefits to society)

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- "Additional" means payment causes additional adoption that would not happen otherwise
- Only additional CO_2 is a benefit of the program
- In ERF, additionality criterion: were farmers doing practice before they sign up?

> (i) at least one of the land management activities is new or materially different from the land management activities conducted during the baseline period;

- Not a reliable measure of additionality

Additionality and no-till

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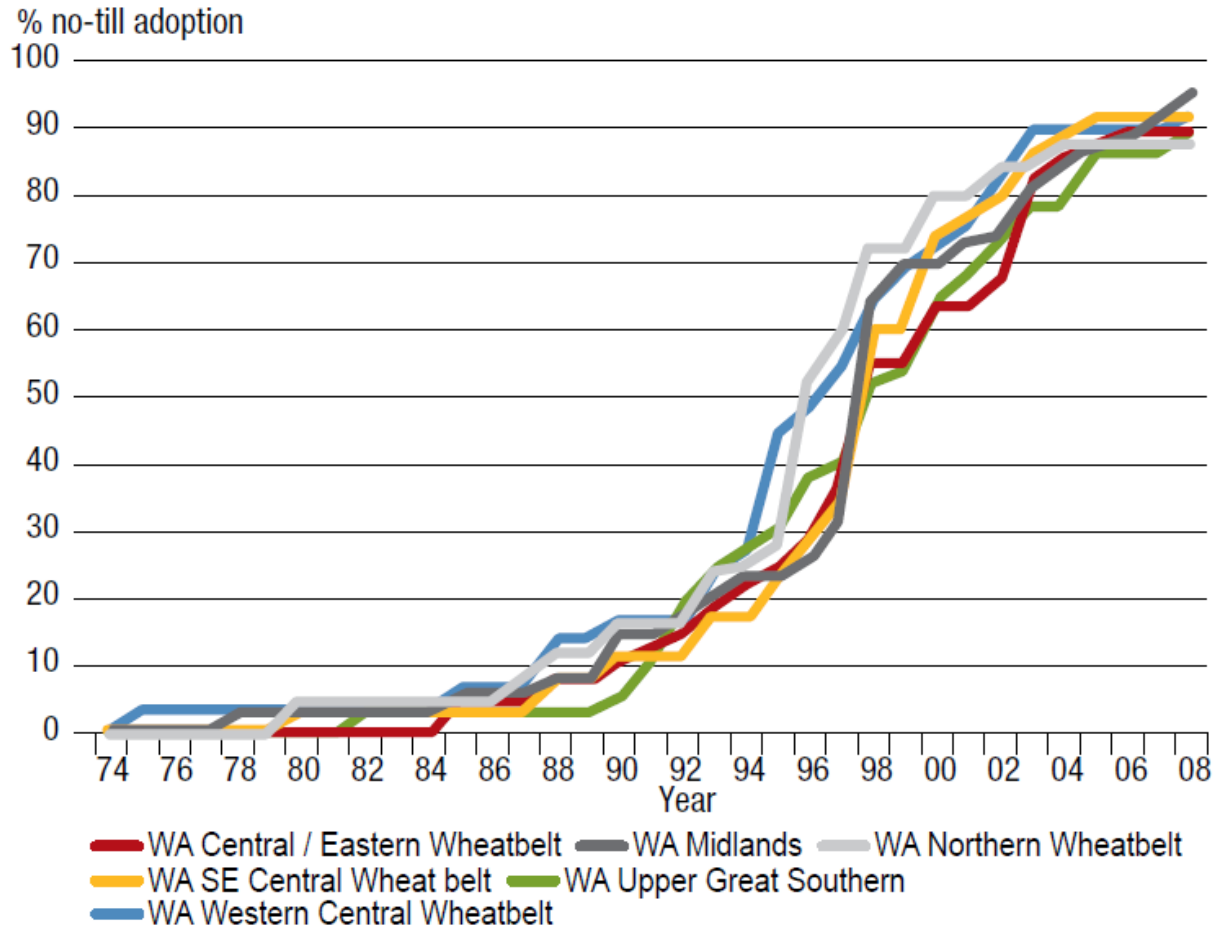
- In 1990 almost all would have been eligible in ERF
- But almost all were non-additional

FIGURE 6 Cumulative adoption of no-till (decision to first use no-till) across WA study areas



Which farmers are additional?

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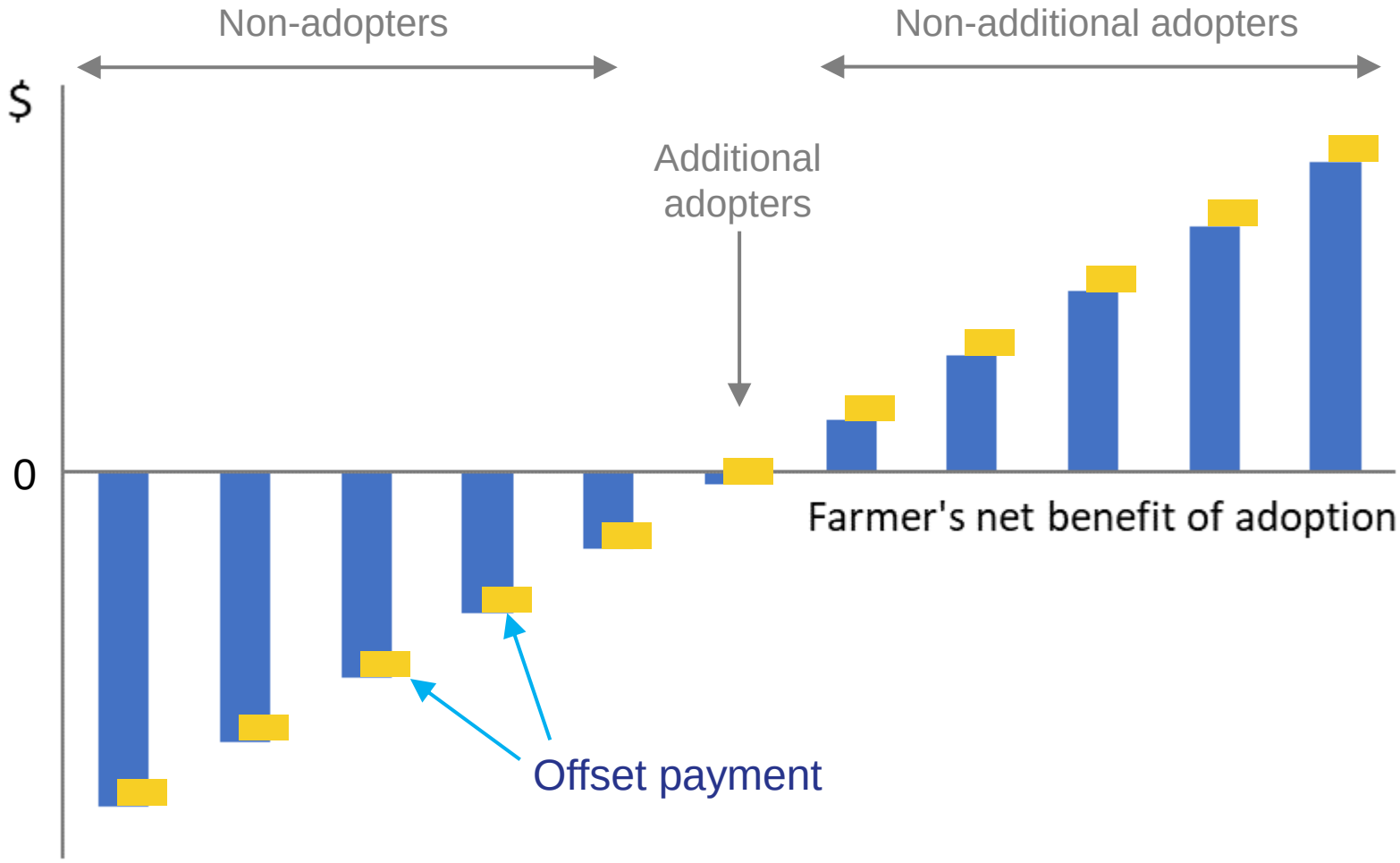
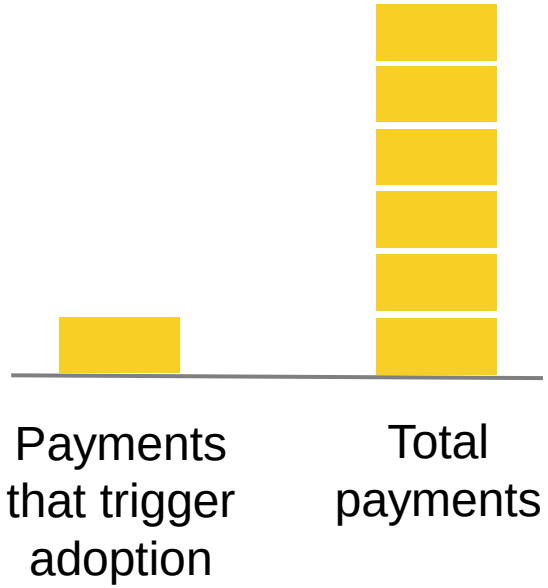


Diverse net benefits of adoption

Payment only triggers a few to adopt

What will happen

- For practices that are well established (adoption stabilised)
  - Non-additional farmers have already adopted
  - Few successful applications
- For practices that are not yet adopted and are attractive (adoption about to grow)
  - Non-additionality not detected
  - Many successful applications, mostly non-additional
  - **Makes the ERF a very expensive way of mitigating climate change**



Private benefits of the practices can be large

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"The benefits for farmers go beyond carbon abatement. An increase in soil carbon improves the soil quality, stores water, and boosts productivity and yields of farmland."

David Littleproud
Minister for Agriculture

Farmers will be *"getting a new revenue stream, improving the productivity of their operations, and they'll be making their land more resilient to things like drought. ... It really is a win-win-win opportunity."*

Shayleen Thompson, Clean Energy Regulator
Executive General Manager, Scheme Operations Division

Could we fix additionality assessment?

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- Need to predict individual farmer's behaviour with and without small payments
- Finding small number of additional applicants = needle in haystack
- Impossible

Is paying for soil C good climate policy?

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- Two possible outcomes
  - Few successful applications → ineffective
  - Many successful non-additional applications → expensive
- If policy looks successful, ring alarm bells

What should we do?

- Government should stop issuing contracts for soil carbon in the ERF
- Change tack: trials and extension about relevant practices to facilitate farmers adopting for private benefits
- Explore other options for agriculture

An option – reduce methane emissions

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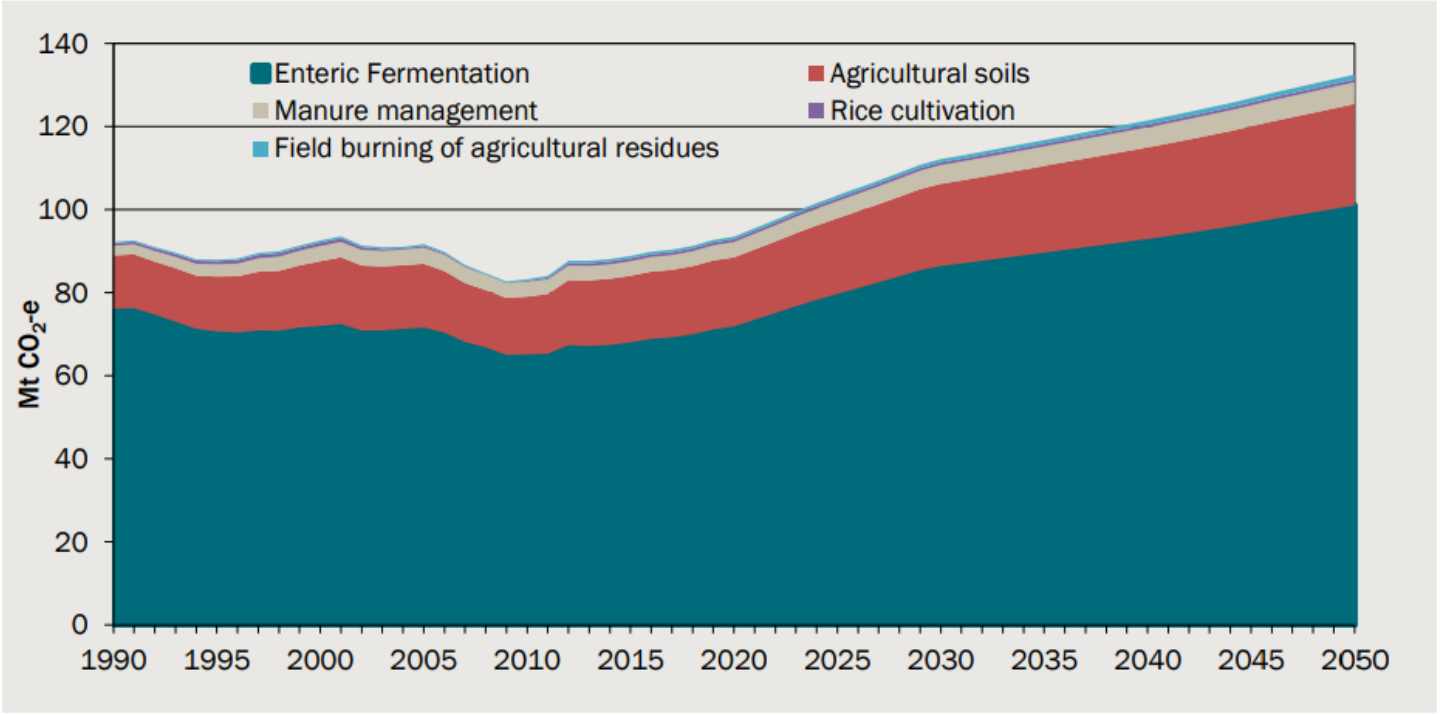
- Most agric emissions come from livestock
- Some feed supplements reduce CH_4 emissions
- Two methods available for beef and dairy



Note: All emissions are calculated using AR4 global warming potentials. Average emissions reported.

Data source: DIICCSRTE emissions template, CIE projections

- R&D to develop and prove better methods and promote them

We were doing this

- There was a major research program on this in Australia starting in 2007
- Good initial progress was made – Australia was a world leader
- The program was cancelled by the Abbott government prior to implementation
- Should be reinstated and expanded

How did we get here?

- Misguided enthusiasm
  - Persuasive passionate people
  - Looks good superficially
  - Policy ideas get momentum
- Incompetence
  - Failure to understand additionality
- Political expediency
  - Keen to pay farmers
  - Need to look like doing something
  - Tax-payers/voters not well informed

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Could soil carbon sequestration ever be a worthwhile climate policy?

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