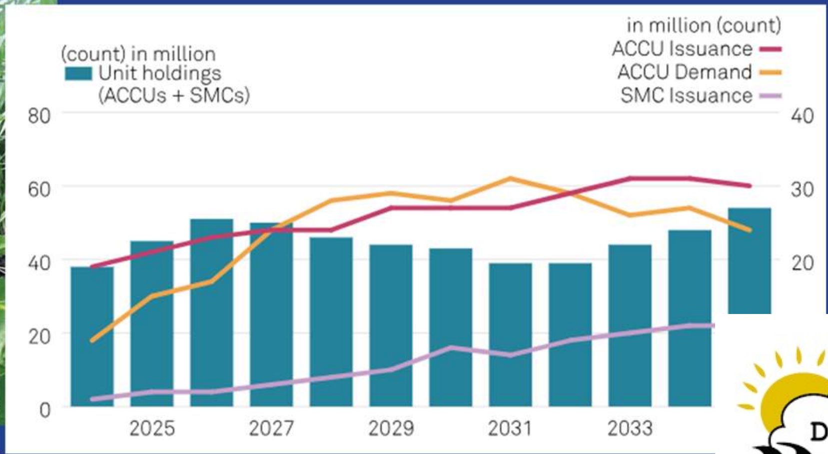
Soil carbon project potential and measuring agronomic benefits



A REPORT PREPARED BY AG ECON FOR THE DRYLAND COTTON RESEARCH ASSOCIATION

APRIL 2025

Abstract

- Each case study site found a positive net present value (NPV) and internal rate of return (IRR) from changing from a baseline practice to a carbon-focussed rotation whilst participating in an ERF carbon project
- Financial results were highly sensitive to long-term increases in cropping yields, and moderately sensitive to soil carbon sequestration
- Changes in the discount rate and future ACCU prices were found to have more limited impacts on the financial results
- All three case study farms were found to be either carbon neutral or net carbon sinks, owing to sequestration from non-cropped areas

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Project aims

Scenarios: native vegetation, ACCU price impact sensitivity

Does shifting agronomy to a carbon farming project/rotation pay in the long-run?

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Case study sites

Case study analysis – Gross Margin and ACCU Carbon Farming project economics

Douglas Station – NT

- Total holding of 23,152 ha
- 500 ha of cropping
- 2,500 ha of riparian scattered woodlands
- 20,000 ha grasslands

Kielli – Darling Downs, Qld

- Total holding of 635 ha
- 500 ha of cropping
- 135 ha of scattered riparian woodlands and grasslands

Blue Hills – Lower Namoi, NSW

- Total holding of 6,578 ha
- 5,060 ha of cropping
- 710 ha of native woodlands
- 808 ha of grasslands

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Methods and workflow

Economics

Carbon Farming – Discounted Cash Flow analysis

Sensitivity testing

Firm up baseline rotation Gross Margins and GHG footprint for each site

Research additionality and site-specific carbon farming rotations, products, GMs and GHG changes

Review CER project technical requirements, table project costs and benefits

Research carbon yields from 'sustainable intensification' in dryland systems

Yield increases from increased carbon stores: Review of literature

ACCU price forecasts: Scenarios for discounted cash flows

Native vegetation: modelling contributions to the landscape carbon balance

Carbon Farming Rotation - Rationale

1. Comply with carbon farming dryland agronomic principles[1]
2. Satisfy CER additionality[2]
3. Offer a realistic and practical alternative to BAU[3]

Carbon Farming Rotation - Rationale

1. Millet cover cropping – a proven addition to building carbon stores, cheaply and efficiently per mm of rainfall.[4]

2. Adding organic fertiliser at planting, with a lower Emissions Factor (EF) than synthetics.[5,6]

Product	N-P-K-S	% Carbon	Bulk cost $/t	Moisture
Terrus Pro	3-1-4-2	28	$600	10-12%
Terrus	3-2-1-1	31	$550	10-12%
Terra Firma	4-2-3-1	37	$300	5-10%

Product Ref: Matt Gardiner, AMPS Research

Carbon Farming – Review of yield impacts

Author	Journal	Study focus	Findings
Vendig, et. al. (2022)	Nature Sustainability	US meta-analysis	0-20.2% yield increase. Yields increased 60% of the time.
Vendig, et. al. (2023)	Nature Sustainability	Global Meta-analysis	Yield response depends on SC %. Range 0-24.3%
Ma, J., et. al (2023)	Advanced Earth and Space Science	Global Meta-analysis	7% increase in soil carbon. 2% increase in production
Oldfield, E.E. et. al (2019)	European Geosciences	Global Meta-analysis	Yield increases 10-37%. When SC levels reached 2% gains slowed
Devereux, A.F., et al (2014)	Agronomy Australia Proceedings	Cotton Yields following corn	Up to 25% cotton yield increase

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Douglas Station, NT

Köppen Classification: Savanna
Mean Annual Rainfall (Pine Creek): 1,146 mm
Altitude: 189m

New Rotation	Cotton	Corn
Revenue	$3,200	$1,750
Costs	$1,811	$1,044
Gross Margin	$1,389	$706

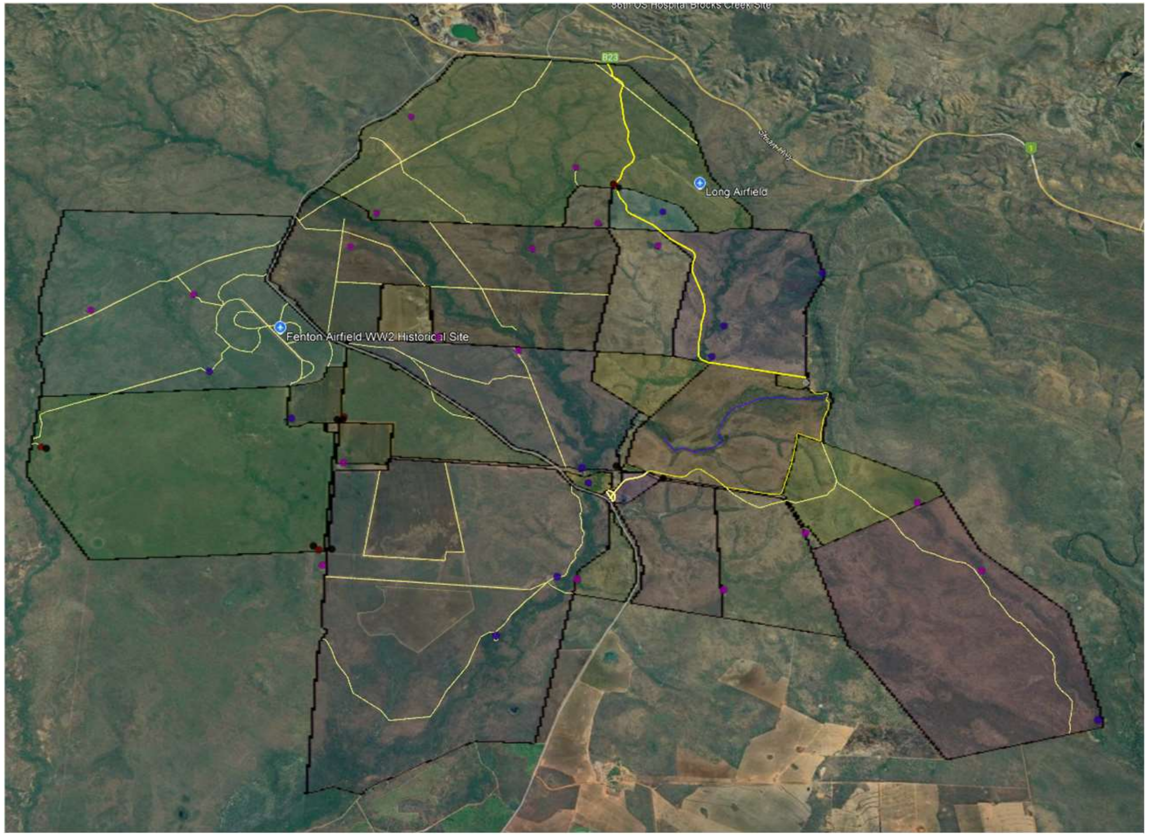
Baseline rotation:

- Cotton-cotton (assumed a 2% yield decline in 10 years - AE)

Carbon Farming Additionality:

- Cotton-cotton-corn
- The introducing of corn to increase soil carbon
- Including 300 kg/Ha Terrus Pro fertiliser with corn

Ref: Greg Nicol



Kielli, Darling Downs

Köppen Classification: Temperate (hot summer)
Mean Annual Rainfall (Kuyura): 589 mm
Altitude: 377m

New Rotation	Cotton	Millet
Revenue	$2,572	$0
Costs	$1,228	$335
Gross Margin	$1,344	-$335

Baseline rotation:

- Cotton-millet

Carbon Farming Additionality:

- Including 300 kg/Ha Terrus Pro fertiliser biennually with millet

Ref: Jamie Grant

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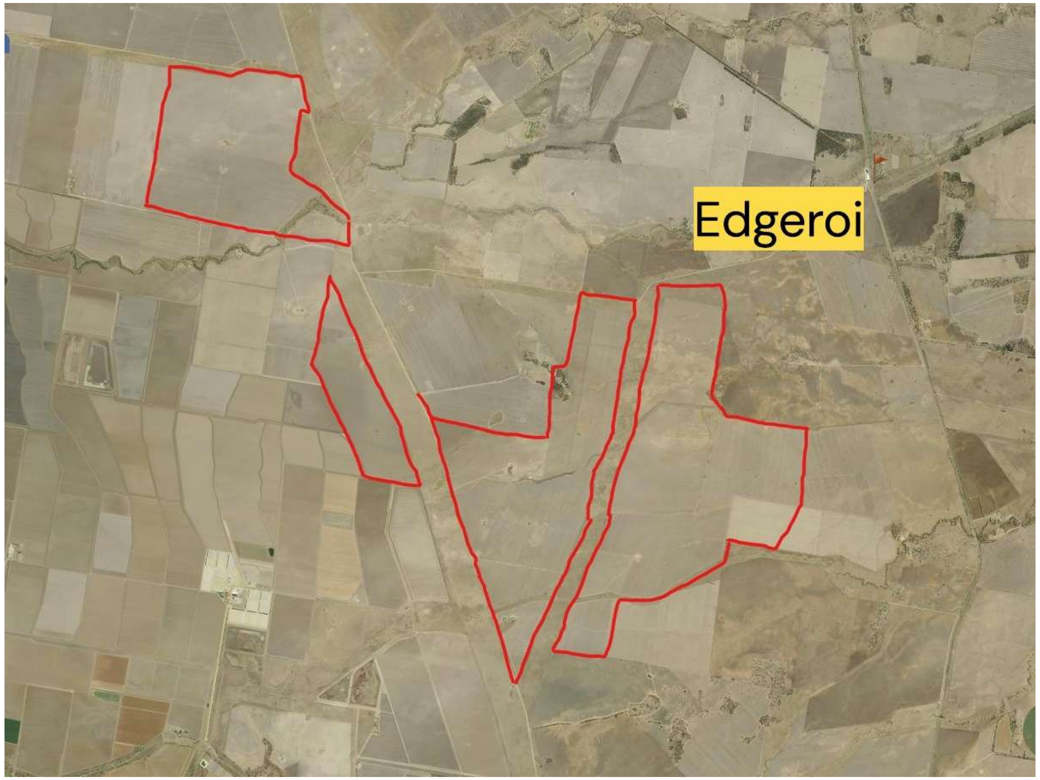
Blue Hills Aggregation, Lower Namoi

Köppen Classification: Subtropical (dry winter)
Mean Annual Rainfall (Murrumbilla): 624 mm
Altitude: 260 m

New Rotation	Wheat	Chickpea	Cotton	Millet	Canola
Revenue	$1,120	$1,600	$2,251	$0	$1,296
Costs	$693	$648	$1,205	$148	$890
Gross Margin	$427	$952	$1,046	-$148	$406



Baseline rotation:
- Wheat-canola-fallow-cotton-chickpea

Carbon Farming Additionality:
- Wheat-canola-fallow-cotton-chickpea-millet
- Including 100 kg/Ha Terrus Pro fertiliser with chickpea, cotton and canola

Ref: Mitch Cuell

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Carbon Project Economics (1)

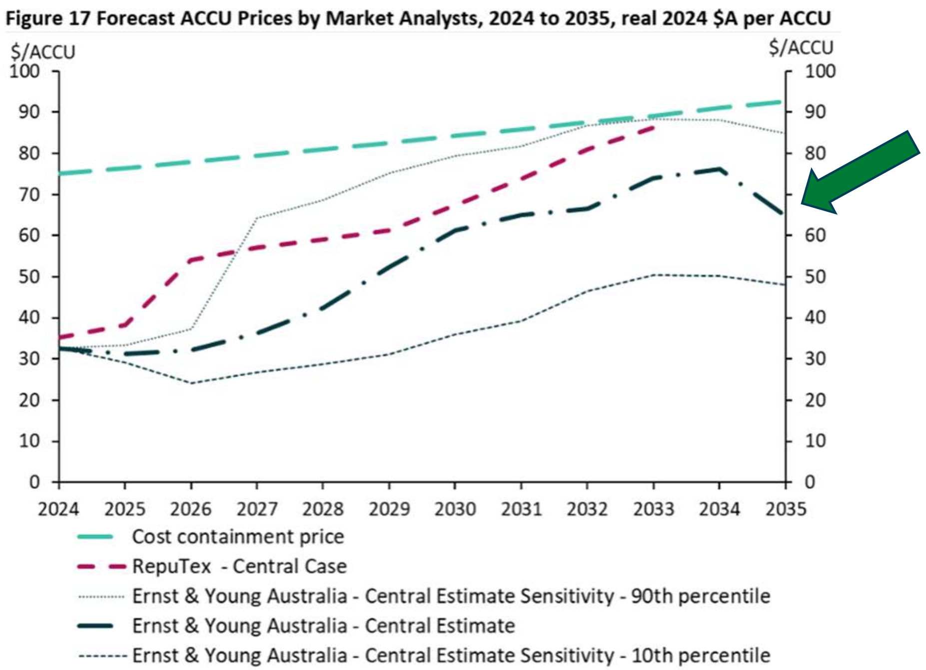
Three carbon yield scenarios (t CO_2e/ha/yr) were modelled for dryland cropping sustainable intensification, as follows[7];

Marginal benefit	Some benefit	More benefit
0.11	0.59	1.65

ERF Soil carbon project costs are tabled as follows[8];

Item	Cost	Occurrence
Project certification	$25/ha	Establishment
Baseline sampling and measurement	$114/ha	Establishment
Maintenance and monitoring	$150/ha	Every 5 years (of 25 years)

Carbon Project Economics (2)

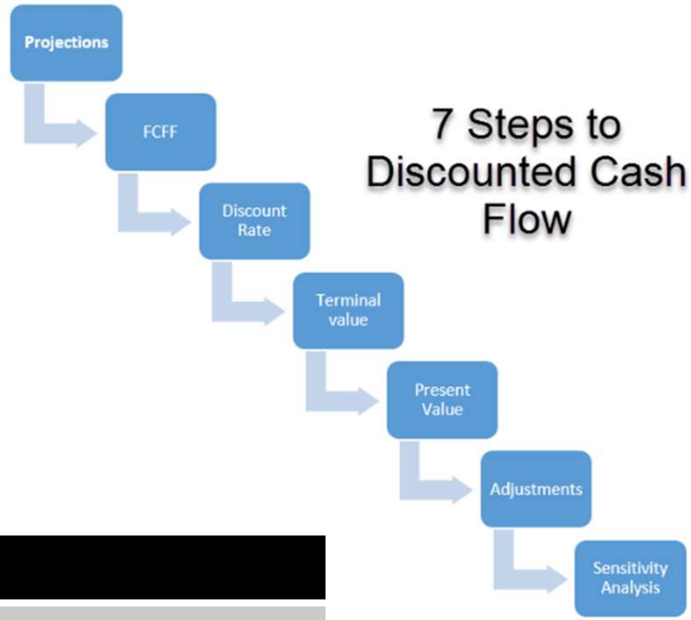


The future ACCU price is a key input into modelling returns of a carbon project. Ernst & Young Central Estimate is used in the DCF analysis.[9]

Method: Discounted Cash Flow

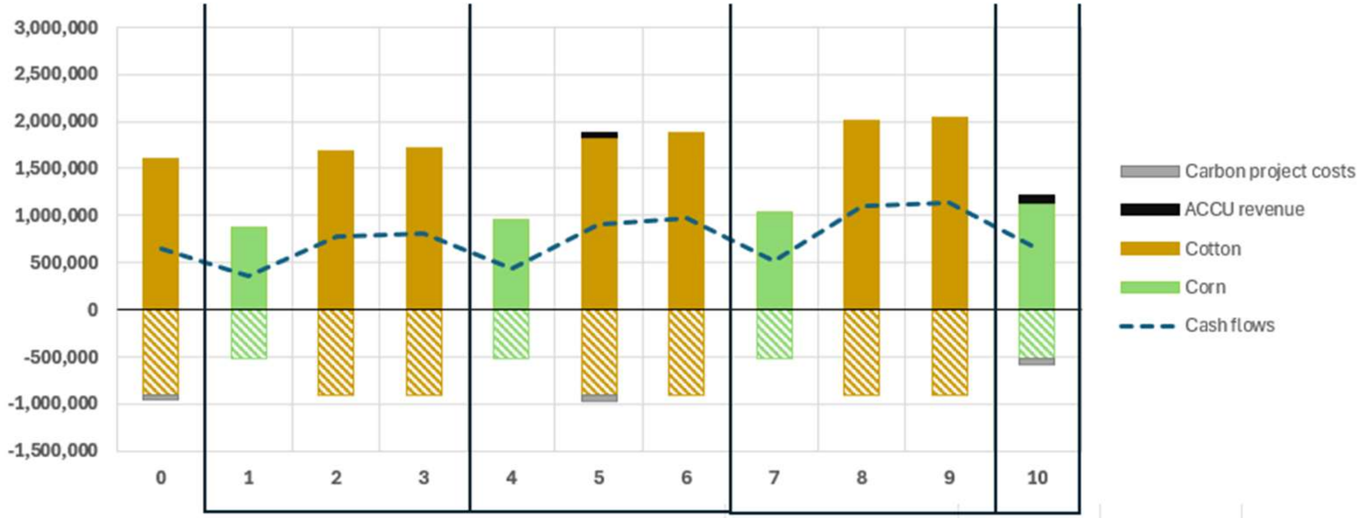
Why use a DCF?

- Used to assess the net present value of future cash flows
- A DCF can better represent the time value of money and anticipated appreciation of ACCUs[10]
- Given the permanence of a soil carbon project, can capture future agronomic land use changes from yield/carbon stores[11]
- Five yearly ERF auditing and compliance costs can be more accurately modelled to present day values
- Only **10 years** of a 25-year project has been modelled



Key DCF Assumptions	
NT Yield changes: -2% cotton on cotton (baseline) [12] +5% after corn (carbon rotation) +2% after other crops (carbon rotation)	DD and Namoi Yield increases: 2%
ACCU indexation: Ernst & Young (2023)	Discount rate: 8%

Results: Douglas Station



Change from base (cotton-cotton)
NPV = $1,233,279 & IRR = 48%

Key findings:

The carbon project net benefits are are small (black/grey bars) when considering project economics.

Agronomic assumptions are driving project returns.

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Results: Douglas Station

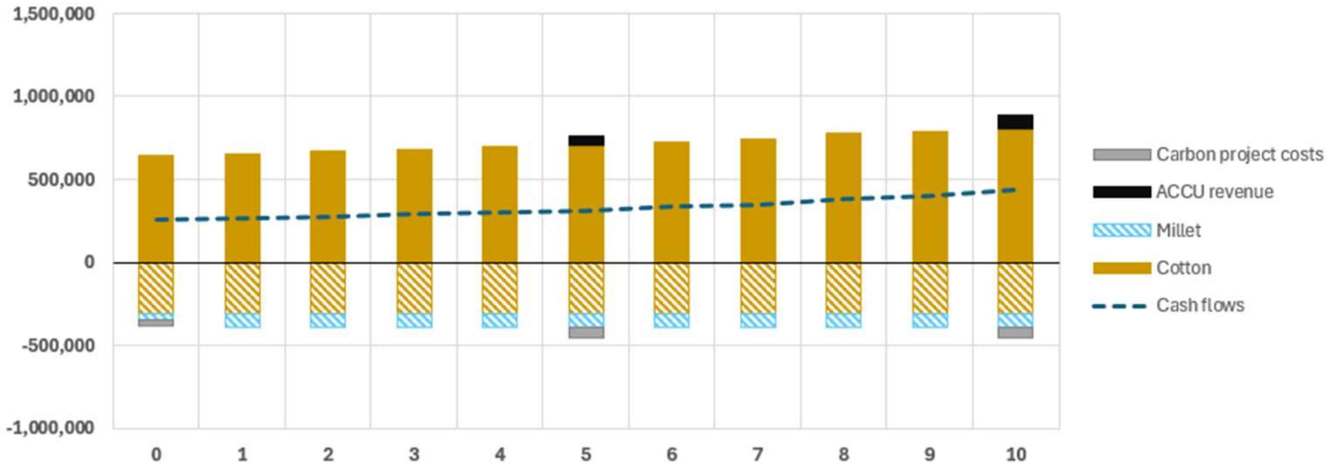
DISCOUNT RATE		5%	8%	10%
NPV	$	**$1,557,048**	**$1,233,279**	**$1,057,537**
IRR	%	**48%**	**48%**	**48%**
ACCU PRICE FORECAST		Flat $18	Flat $35	EY central estimate
NPV	$	**$1,187,456**	**$1,205,589**	**$1,233,279**
IRR	%	**47%**	**48%**	**48%**
SOIL CARBON SEQUESTRATION		Marginal benefit	Some benefit	More benefit
NPV	$	**$1,180,380**	**$1,233,279**	**$1,350,097**
IRR	%	**47%**	**48%**	**50%**
YIELD BENEFIT		0.0%	As above	
NPV	%	**$20,413**	**$1,233,279**	
IRR	%	**9%**	**48%**	

Key findings:

Yield assumptions have the biggest impact on project economics, followed by carbon yield benefits.

Discount rate and ACCU price assumptions only marginally moved the IRR.

Results: Kielli



Key findings:

The carbon project net benefits remain small (black/grey bars) when considering a crop gross margin.

Agronomic benefits exceed costs when assuming a small (2%) cotton yield increase.

Change from base (cotton-millet)
NPV = $124,955 & IRR = 21%

Results: Kielli

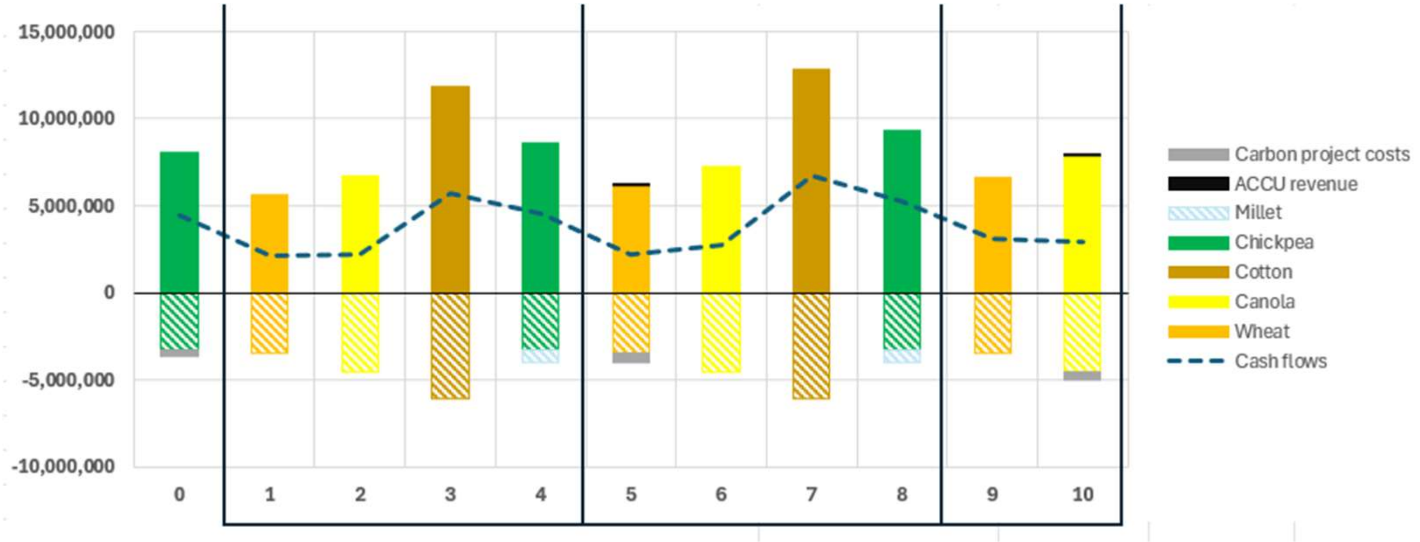
DISCOUNT RATE		5%	8%	10%
NPV	$	**$181,523**	**$124,955**	**$95,077**
IRR	%	**21%**	**21%**	**21%**
ACCU PRICE FORECAST		Flat $18	Flat $35	EY central estimate
NPV	$	**$75,232**	**$94,975**	**$124,955**
IRR	%	**16%**	**18%**	**21%**
SOIL CARBON SEQUESTRATION		Marginal benefit	Some benefit	More benefit
NPV	$	**$65,334**	**$124,955**	**$256,616**
IRR	%	**15%**	**21%**	**30%**
YIELD BENEFIT		0.0%	As above	
NPV	%	**-$353,445**	**$124,955**	
IRR	%	**NA**	**21%**	

Key findings:

Cotton yield benefits underpin the project economics.

Soil carbon yield has a more significant economic impact on this cropping system.

Results: Blue Hills



Change from base

NPV = $932,905 & IRR = 17%

Key findings:

The net carbon project contributions remain small (grey/black bars) when considering a crop gross margin.

The additional cost of millet and organic fertiliser shows a positive economic response applying a 2% yield increase (>Y2-Y10)

Results: Blue Hills

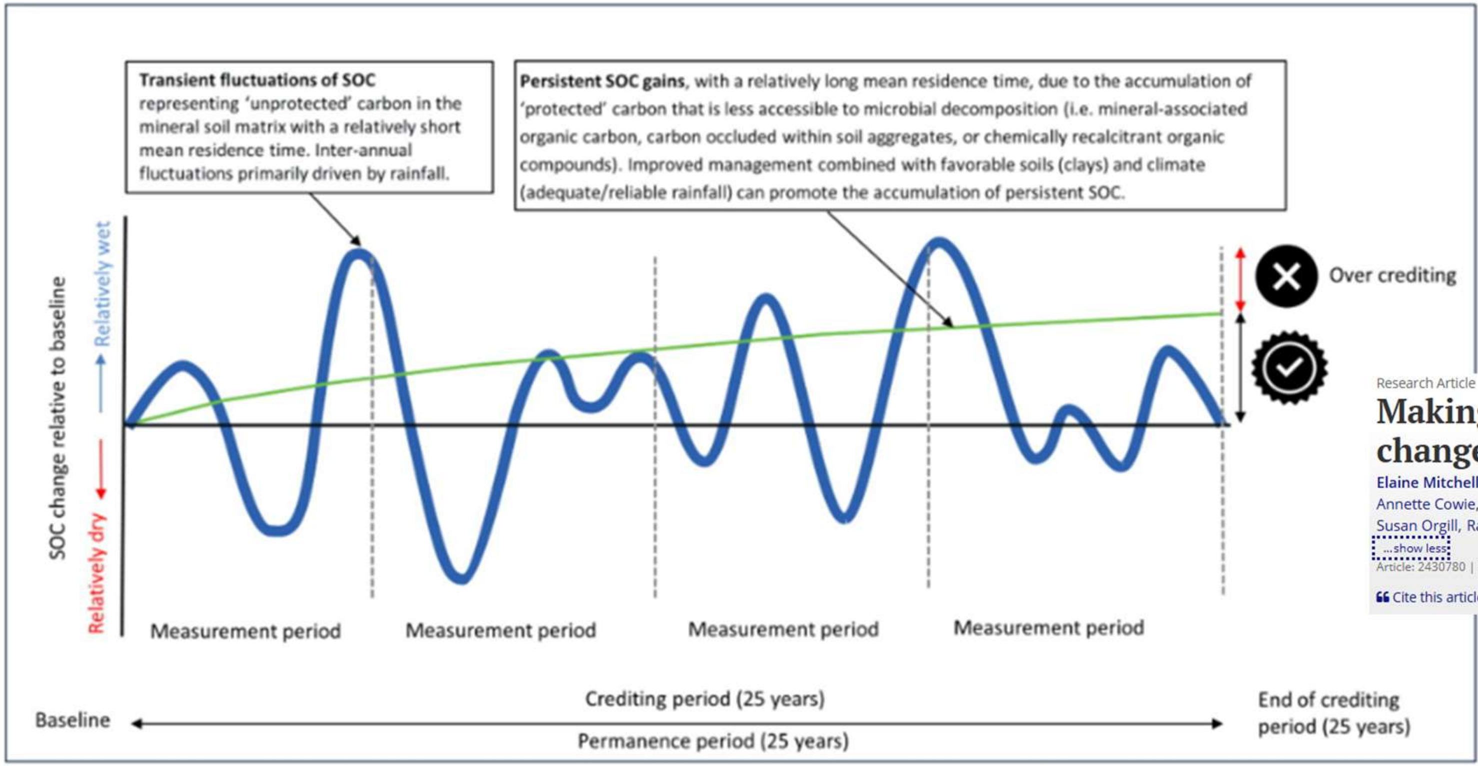
DISCOUNT RATE		5%	8%	10%
NPV	$	**$1,445,718**	**$932,905**	**$661,884**
IRR	%	**17%**	**17%**	**17%**
ACCU PRICE FORECAST		Flat $18	Flat $35	EY central estimate
NPV	$	**$392,636**	**$606,489**	**$932,905**
IRR	%	**12%**	**14%**	**17%**
SOIL CARBON SEQUESTRATION		Marginal benefit	Some benefit	More benefit
NPV	$	**$276,896**	**$932,905**	**$2,381,591**
IRR	%	**11%**	**17%**	**27%**
YIELD BENEFIT		0.0%	As above	
NPV	%	**-$3,225,200**	**$932,905**	
IRR	%	**NA**	**17%**	

Key findings:

The model is highly sensitive to future yield benefits

Soil carbon yield assumption has a significant economic impact on this cropping system with increased intensification (I.e. more crops = more carbon).

Carbon stores will fluctuate with rainfall



Research Article

Making soil carbon credits work for climate change mitigation

Elaine Mitchell, Naoya Takeda, Liam Grace, Peter Grace, Ken Day, Sahar Ahmadi, Warwick Badgery, Annette Cowie, Aaron Simmons, Richard Eckard, Matthew Tom Harrison, William Parton, Brian Wilson, Susan Orgill, Raphael A. Viscarra Rossel, David Pannell, Paige Stanley, Felicity Deane & David Rowlings
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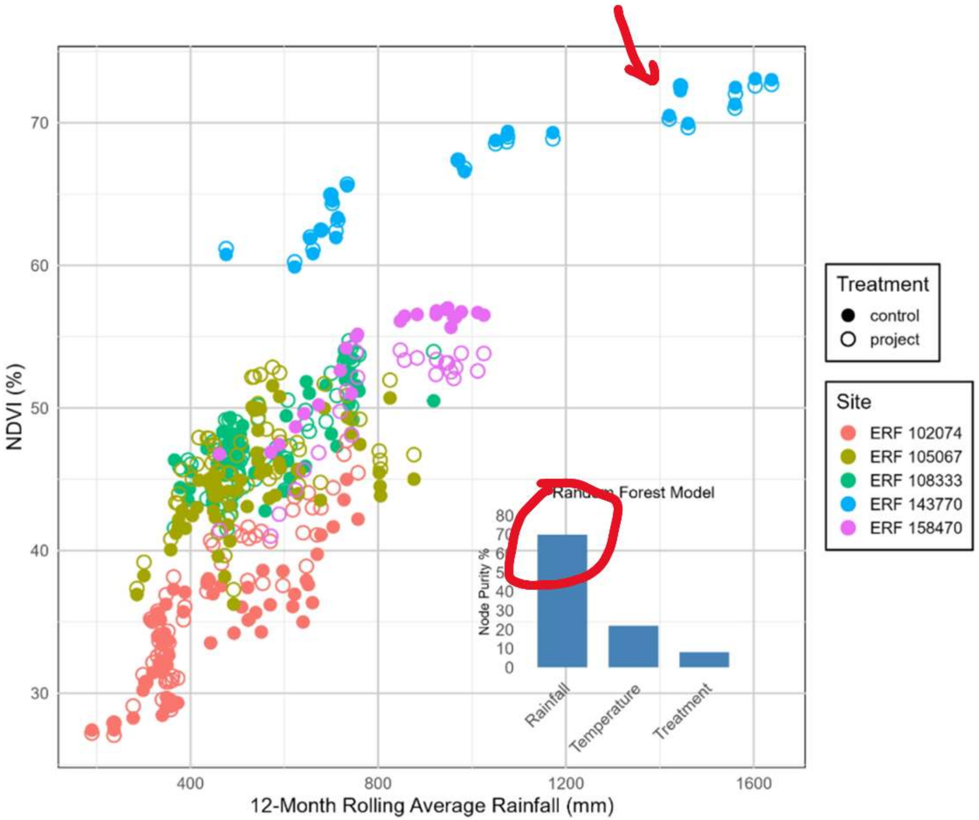
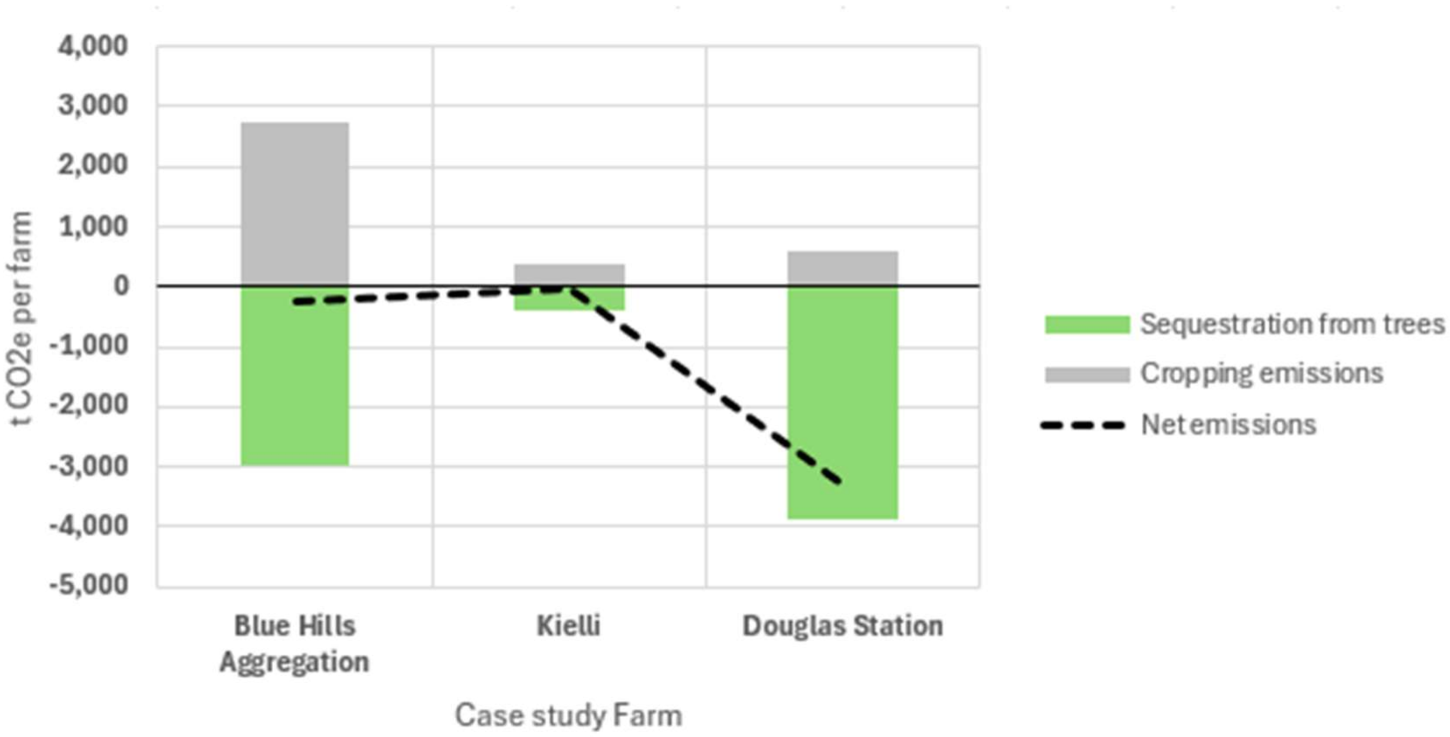
https://www.tandfonline.com/doi/full/10.1080/17583004.2024.2430780#abstract

Carbon stores will fluctuate with rainfall



The key recommendation found carbon yield stores are over-estimated and rainfall is the key driver of soil carbon.

Vegetation and carbon balance



Analysis of cropping emissions found all sites were carbon positive or neutral (Source: G-GAF carbon tool)

Vegetation and carbon balance [14, 15]

Veg type	Structure	t CO_2e Ha yr
Riparian River Redgum	Old growth, some thinning	7.60
Coolibah woodland	Mature and regenerating trees	1.84
Brigalow	Pockets of dense regen	2.39
Poplar box and brigalow	Open brigalow	2.20
Tropical pasture	Bambatsi, Rhodes grass etc.	0.99
Native grasses	Mix of species	0.99

Carbon yield from vegetation in non-cropped areas can vary greatly, depending on species assumptions

Discussion and conclusion

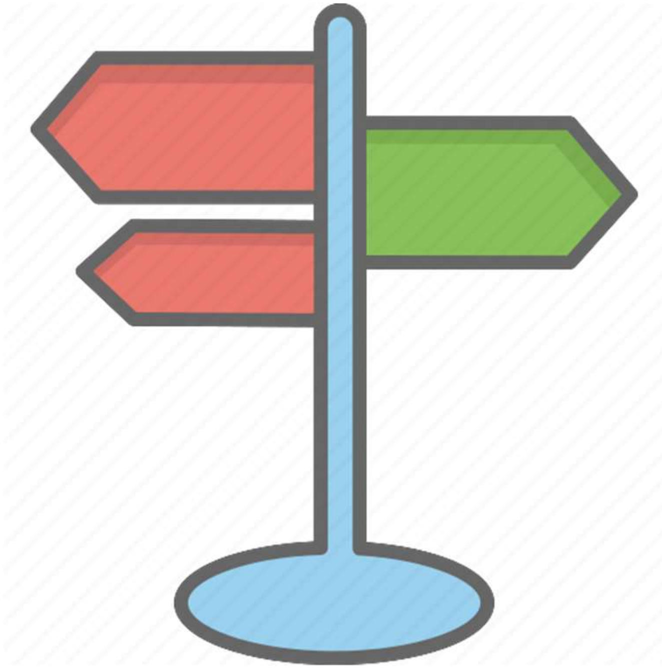
- An ERF soil carbon project has limited economic opportunities due to high start-up/compliance costs and uncertain carbon yield outcomes.

- Agronomic benefits from increased soil carbon drive system profitability through increased soil health and crop yields.

- Modelled returns were highly sensitive to yield increases over the 10-year analysis period in all case studies.

- A review of organic fertiliser found organic/manure-based products have an estimated 33% lower **Scope 3** carbon footprint than synthetic fertiliser. Local results are finding crop yield benefits.

- A high-level analysis of vegetation of non-cropped areas can offset cropping-based emissions, with each case study site either carbon neutral or a net carbon sink.



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Thank you.

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