Growing revenue using carbon shelterbelts

Case Study 9, Alawoona

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Ai CARBON
Australian Integrated Carbon

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- *This report provides pricing scenarios to help understand potential revenue returns. We use four pricing scenarios:*
    - *Auction price of \$17.35/tCO_2e - the average price in the last ERF auction in April 2022*
    - *Low price \$32.00 - \$51.00/tCO_2e*
    - *Base price \$35.00 - \$71.00/tCO_2e, Compound Annual Growth (CAG) of 2.8 % over 25 years*
    - *High price \$42.00 - \$105.00/tCO_2e, or Compound Annual Growth (CAG) of 3.3 % over 25 years.*

- *The Low, Base and High scenarios are based on pricing information obtained from Reputex, which provides a subscription service to market participants and governments on carbon market dynamics, trends and outcomes. The pricing was current on 22 July 2022. More information about Reputex can be found at https://Reputex.com.*

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- *This report uses carbon yields calculated using the Clean Energy Regulator's carbon assessment tool (FullCAM), the outputs of which may vary depending on a range of input variables. Carbon yields cannot be finalised until any Australian Carbon Credit Units (ACCU) volumes have been approved by the Clean Energy Regulator (CER) and/or project auditor. As such, carbon yields per hectare should be considered as estimates at this stage.*

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1. Introduction

The Murraylands and Riverland region of South Australia is a dryland agricultural area with an average rainfall of 300-400mm, but is prone to reduced rainfall during El Nino events. Farms in the area have recently suffered a run of dry seasons. This project was funded by the Department of Agriculture, Water and Environment and the Future Drought Fund to investigate whether carbon shelterbelts could provide a useful income source during dry times.

The simplest approach to engaging in the carbon market is to use methods that conform to Australian Government carbon methods. The approach that relates best to shelterbelts is the Reforestation by Environmental or Mallee Plantings Method (Clean Energy Regulator 2022a) which uses a computer model (Full Carbon Accounting Model, FullCAM) to estimate carbon yield based on location (Department of Climate Change, Energy, the Environment and Water 2022). For projects registered with the Australian Clean Energy Regulator, carbon yields can then be converted to yield in tonnes of carbon dioxide equivalent (tCO_2e), with 1 tCO_2e of greenhouse gas storage or abatement generating one Australian Carbon Credit Unit (ACCU, Clean Energy Regulator 2022b).

The aim of this project was to identify 10 case study sites across the Murraylands and Riverland region, then develop a planting layout, use FullCAM to model carbon sequestration, and estimate costs and revenue associated with the planting. The project targeted all six council areas in the Murraylands and Riverland where typical 'mixed farming' occurs, namely, The Coorong, Karoonda East Murray, Mid Murray, Murray Bridge, Southern Mallee and Loxton Waikerie council areas.

There was significant farmer interest in how carbon shelterbelts would affect the farm carbon account if carbon credits are not sold, but are instead used to offset farm emissions. This interest was driven both by a desire to contribute to the effort to reduce global warming, and because farmers may in future be required to offset emissions to avoid tariffs in some markets (e.g., the EU, see Martin 2021). In response, case studies were expanded to include a simple farm carbon account, and consideration of how sequestration in shelterbelts may impact net farm emissions.

2. Case Study 9 – Background

The Alawoona district is approx. 220 km east of Adelaide in the Murray Mallee. Average annual rainfall is approx. 300 mm and soils are mostly well drained sands and sandy loams over clay. Farms in these districts tend to be around 3000 to 5000 ha, and many farms crop about half their area to wheat, barley and pulses, and run livestock (Merino sheep) on the remaining farm area.

The northern Mallee is of particular interest in this carbon shelterbelts project because:

a) farms in the region is sufficiently large that some land (50-100 ha) could be spared for tree planting without obviously limiting crop and pasture area; and
b) rainfall and soil type can still allow successful direct seeding of mallee trees.

Rather than just focusing on a particular farm, this case study focuses on the economic feasibility of shelterbelts on a theoretical 'average farm' – a 4,000 ha property running a self-replacing flock of 1,500 Merino ewes, and cropping 2000 ha with mainly wheat and barley. It is hoped that 'rules of thumb' identified in this study can provide useful guidance to farmers and land managers across the northern Mallee.

Reasons farmers give for planting shelterbelts on farms include:

- returning more vegetation to the landscape
- habitat for wildlife
- extra shade and shelter for sheep, particularly lambing ewes
- shelter from strong winds for crops, particularly pulse crops that are susceptible to hot winds in spring
- earning extra income from carbon sequestration, or generating enough offsets to be considered a low emissions property, potentially giving access to low carbon markets
- improving farm aesthetics.

3. Shelterbelt design

The main principles to consider in shelterbelt design include:

- Protection of paddocks or livestock from cold winds (usually from the south and west), and crops from hot winds
- planting along existing fences can improve biosecurity and reduce fencing costs
- plant on least productive soils
- link remnant vegetation where possible

The species chosen for the design was 'mallee eucalypt species', since local mallee trees are drought and fire resistant, maximise carbon yield, and are easier to establish than many shrubs (Noble and Bradstock 1989). For large scale plantings, direct seeding is used for establishment as it is more economical. Planting density generally targets 800-1500 stems/ha in the Mallee.

To conform with the relevant Australian Government method, belt plantings can be narrow linear or wide linear, but for carbon shelterbelts wide linear design is normally chosen (3-8 rows of trees with rows < 4 m apart).

To have a significant impact on both the landscape and a typical farm footprint, plantings are often in the order of 40-140 ha. For this case study, an area of 80 ha was chosen, which represented 2 % of the nominal farm area.

4. Cost of establishing shelterbelts

Cost estimates for establishing shelterbelts are shown in Table 1. Fencing costs for 80 ha of belt plantings were based on a contract rate of $5000/km for 40 km of Cyclone and steel post fencing ($80,000), and $1000/ha was allowed for site preparation and direct seeding 80 ha ($80,000). At these rates, the total cost of fencing and tree planting would be $280,000. A figure of $20,000 was allowed for post-seeding weed control (spot spraying) and for fence repairs over time.

Table 1. Cost estimates for shelterbelt establishment.

Item	Unit cost	Cost on 80 ha
40 km fencing	$5000/km	$200,000
80 ha seeding	$1000/ha	$80,000
Post-seeding weed control, fence repairs		$20,000
Total		**$300,000**

Costs associated with developing, registering and auditing the project have not been included. The Clean Energy Regulator is developing a pilot program to assist landholders to enter the carbon market, but at present, this is still in a trial phase (see environmental plantings pilot, Clean Energy Regulator 2022c). It is likely some landholders may require the services of a carbon developer to assist with mapping, carbon modelling, registration, and audits. However, at this stage these costs are difficult to define and have not been included.

The total cost of establishing the project was thus estimated at $300,000. These cost estimates are a guide and will change depending on soil, slopes, condition of pastures and weeds.

5. Estimating carbon yield and revenue

The FullCAM model was used to calculate project carbon yield in tC/ha over a 25 year period at four locations within the belt design of the property (see Figure 1 for example FullCAM curve). The four FullCAM yield curves were then converted to yield in CO_2e. These four curves were highly similar (Fig. 2), with yields highest in years 3 to 10 when trees grow fastest (approx. 10-18 tCO_2e/ha/yr), dropping to 4-10 tCO_2e/ha/yr in later years.

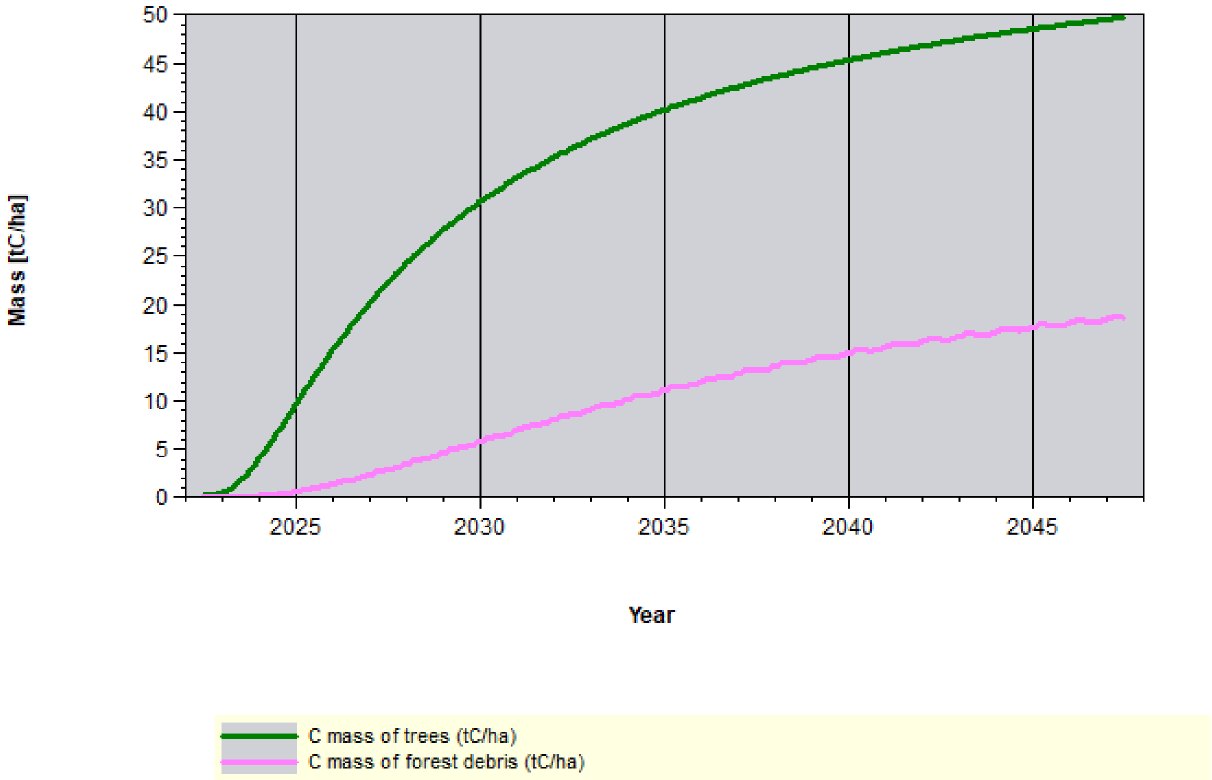

Fig. 1. FullCAM output from one site at Alawoona showing cumulative carbon yield (tC/ha) over 25 years with mallee eucalyptus species planted in a belt at <1,500 stems/ha.

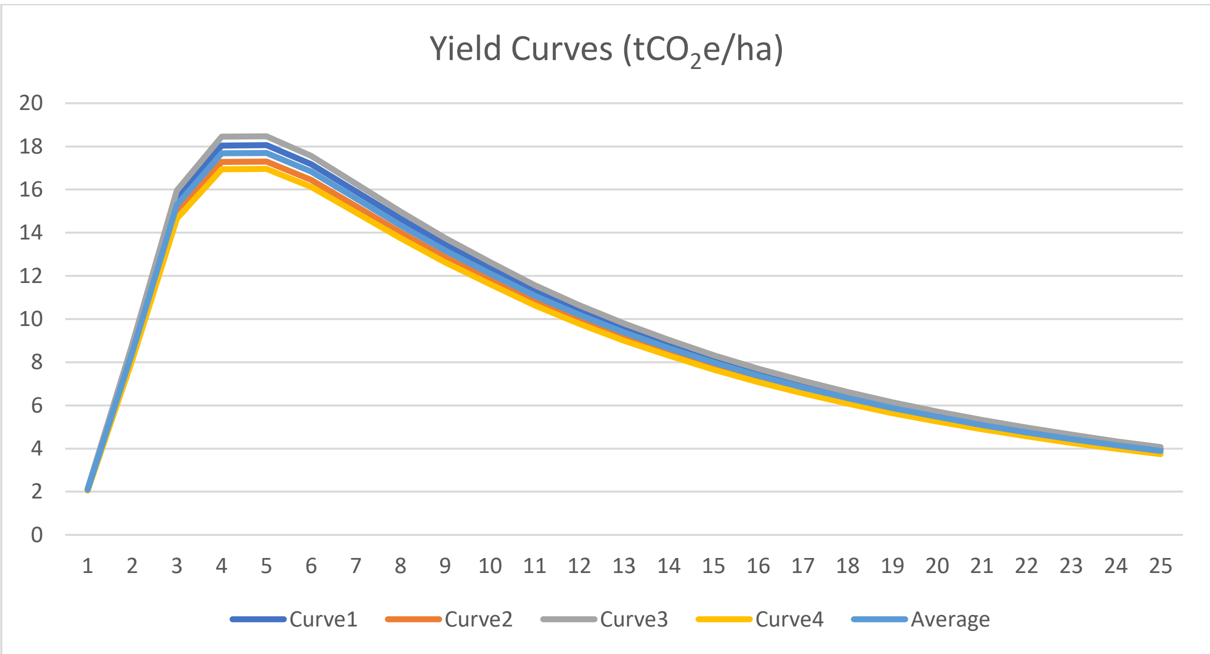

Fig. 2. Yield curves (tCO_2e/ha) at 4 different locations near Alawoona over 25 years.

An average of the four curves was used to calculate project yields across 80 ha. These calculations included the 25 % yield reductions applied to 25 year vegetation projects (5 % risk reversal buffer and 20 % permanence buffer, Clean Energy Regulator 2022d, 2022e). Cumulative project yield was estimated to be 14,091 tCO_2e (Fig. 3), equating to 564 tCO_2e/yr (Fig. 4), or 7.1 $tCO_2e/ha/yr$.

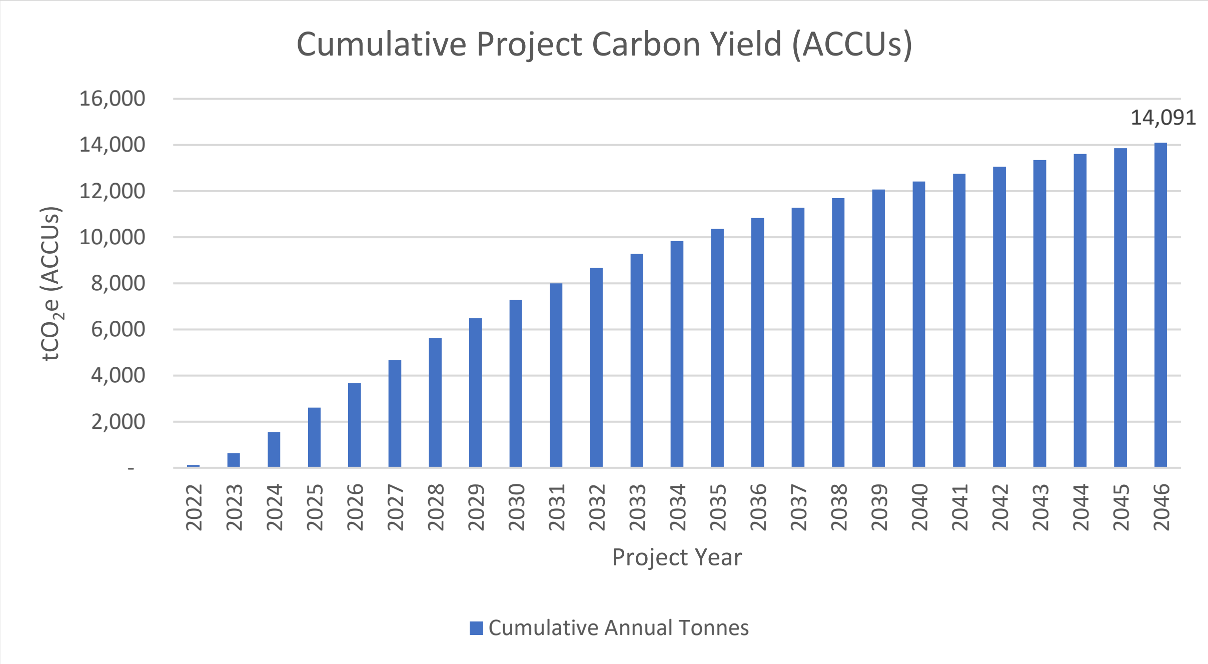

Fig. 3. Cumulative carbon yield from the 80 ha carbon estimation area at Alawoona over 25 years.

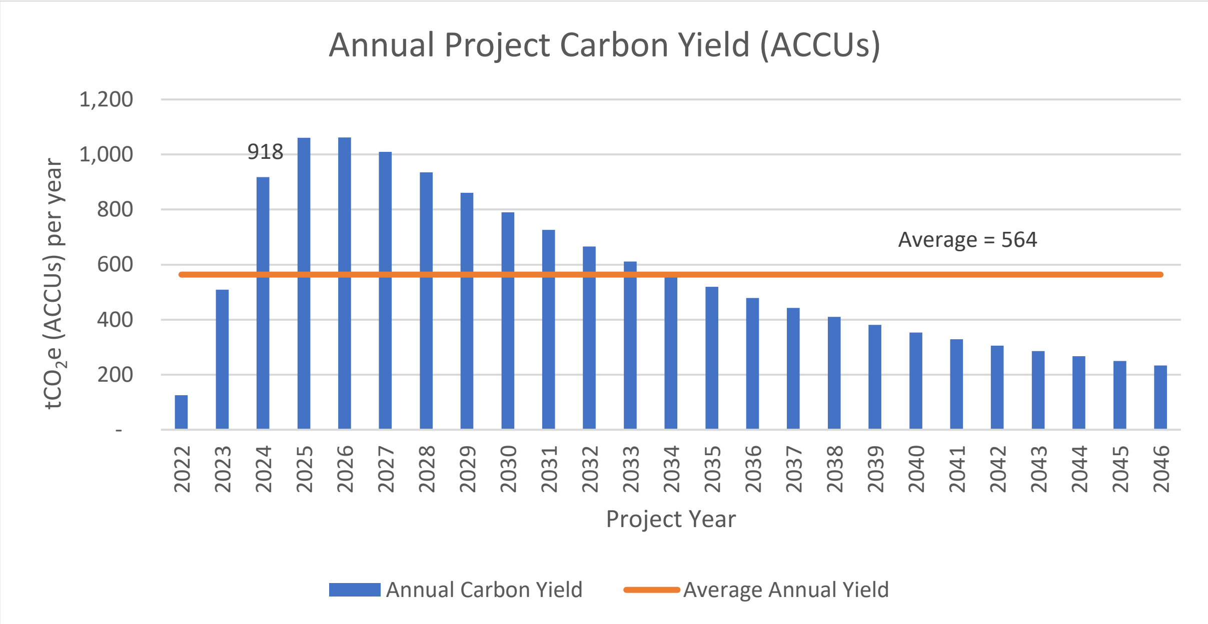

Fig. 4. Annual carbon yields (tCO_2e/yr) calculated from 4 different locations at Alawoona over 25 years, and average annual yield across all years.

Project revenue calculations were based on average carbon yield and flat, low, base and high carbon prices projected over 25 years (Table 2). Carbon prices were based on information from Reputex (https://Reputex.com) on 22/7/2022. The flat price was $17.35/t, the average carbon price in the last ERF auction (April 2022); the low price was $32/t (current spot price) increasing to $51/t and averaging $46.82/t; the medium price was $35/t increasing to $71/t averaging $64.07/t; and the high scenario was $42 increasing to $105 averaging $93.84/t.

Revenues under the flat, low, base and high pricing scenarios totalled $244,000, $660,000, $903,000 and $1.32m, respectively, and annual incomes of $9,800, $26,000, $36,000 and $53,000. Because annual carbon yields were at their highest in years 3 to 10, revenue was also greatest in those years ($16,000-$86,000/yr).

Table 2. Project revenue for the average carbon yield at different pricing scenarios.

Yr	Calendar	Annual Tonnes	Auction Scenario	Low Scenario	Base Scenario	High Scenario
			Flat $17.35	$32 to $51 (avg $46.82)	$35 to $71 (avg $64.07)	$42 to $105 (avg $93.84)
1	2022	126	$2,179	$4,019	$4,396	$5,275
2	2023	508	$8,820	$18,301	$21,351	$28,468
3	2024	918	$15,928	$35,805	$45,903	$65,183
4	2025	1,061	$18,405	$43,493	$57,283	$80,621
5	2026	1,062	$18,421	$44,593	$59,457	$87,063
6	2027	1,010	$17,519	$44,430	$61,595	$85,830
7	2028	935	$16,227	$42,087	$57,987	$86,980
8	2029	861	$14,940	$40,472	$57,694	$86,110
9	2030	790	$13,713	$38,729	$52,956	$80,619
10	2031	726	$12,605	$37,051	$51,581	$76,281
11	2032	665	$11,544	$33,934	$47,241	$69,864
12	2033	611	$10,609	$31,185	$43,415	$64,205
13	2034	563	$9,763	$28,699	$39,954	$59,087
14	2035	519	$9,012	$26,491	$36,879	$54,540
15	2036	479	$8,305	$24,412	$33,985	$50,260
16	2037	443	$7,679	$22,571	$31,422	$46,470
17	2038	410	$7,111	$20,901	$29,098	$43,032
18	2039	380	$6,600	$19,402	$27,010	$39,945
19	2040	353	$6,124	$18,002	$25,061	$37,062
20	2041	328	$5,697	$16,746	$23,314	$34,478
21	2042	306	$5,308	$15,602	$21,720	$32,121
22	2043	285	$4,953	$14,558	$20,267	$29,972
23	2044	267	$4,626	$13,597	$18,929	$27,994
24	2045	249	$4,328	$12,722	$17,711	$26,192
25	2046	234	$4,055	$11,919	$16,593	$24,539
Total		**14,091**	**$244,471**	**$659,720**	**$902,803**	**$1,322,190**
Average			**$9,779**	**$26,389**	**$36,112**	**$52,888**

6. *Costs and benefits*

- Project costs and benefits are summarised in Table 3. Project feasibility is assessed using the base scenario, which assumes that ACCUs are sold, resulting in $903,000 total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at $300,000, noting that costs could be greater in some landscapes or if consultants were used.
- Carbon income was estimated to be $603,000 greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 3:1. Based on the revenue flows shown in Table 2, and assuming carbon was sold at the base rate, establishment costs would be recovered after 7 years.
- Though shelterbelts do take land out of production, and compete with adjacent pastures and crops, this impact can be offset by increased pasture and crop production due to reduced windspeeds across the farm (Bulman and Dalton 2000).
- A co-benefit from extra shelter in the Alawoona area may be improved lamb survival (Gregory 1995, Summers et al. 2019). A 3 % improvement in lamb survival per year in a 1,500 ewe flock could increase returns from lamb production by $6,750 per year (45 extra lambs @ $150), or $168,000 over 25 years, if stocking rates were maintained at current levels.
- Other co-benefits would include reduced dryland salinity risk, and improved animal welfare and production (Bulman and Dalton 2000), but are harder to quantify.

Table 3. Summary of costs and benefits if ACCUs are sold.

Item	**Costs or Benefit**
Establishment costs	$300,000
Carbon revenue, base case	$903,000
Potential profit	$603,000
Ratio of revenue to establishment costs	3:1
Time until costs recovered	5 years
Possible value of extra lambs if lambing survival lifts 4 %	$168,000

7. *Offsetting farm emissions*

- Many farmers are more interested in offsetting their own emissions than selling ACCUs due to a desire to progress towards carbon neutrality. Under this scenario, ACCUs would be generated by the business but then 'retired' (e.g., see Weidemann and Longworth 2021).

- Calculating a full emissions profile for the case study farm was beyond the scope of this study, but most cropping operations emit approx. 0.3 tCO_2e per tonne of cereal grain and 0.24 tCO_2e/t pulses (Western Australian Department of Agriculture and Food 2022). The theoretical farm in this case study would produce approx. 2500 t grain in an average year and 750 tCO_2e from cropping. For the sheep enterprise, approx. 80 % of emissions come from enteric methane, with the remaining 20 % generated from fertiliser use, diesel fuel and electricity supply (Weidemann and Dunn 2021). Using the ESB-GAF accounting tool (Primary Industries Climate Challenges Centre 2022), and assuming the case study farm runs 1,500 ewes, the sheep likely produce another 700 tCO_2e/yr.
- With the present project offering the opportunity to offset 564 tCO_2e each year for 25 years, the proposed shelterbelts would offset 39 % of farm emissions, which may give access to low carbon grain and lamb markets in future.
- To achieve carbon neutrality, the theoretical farm described here would need to pursue further abatement and offset activities – for example, a larger tree planting project, or soil carbon sequestration, anti-methanogenic supplements, solar electricity generation, or replacing some livestock with crops. Alternatively, carbon credits could be purchased from carbon projects registered with the Clean Energy Regulator.

8. Conclusions

- Using the base case pricing forecast, carbon revenue from shelterbelts in the Alawoona region was estimated to be 3 times higher than the cost of establishment, with establishment costs recovered after 7 years.
- Once co-benefits such as improved lamb survival and animal production are considered, the proposed carbon shelterbelts project is even more likely to be profitable.
- Other co-benefits such as improved biodiversity, reduced dryland salinity, reduced erosion and improved aesthetics are more difficult to quantify but would also be beneficial.
- Results of this study suggest that carbon shelterbelts provide a viable way of creating extra farm revenue or offsetting a significant proportion of farm emissions.
- Further work and pilot studies are required to better define costs farmers may incur with project registration, auditing, reporting and brokerage, or develop resources to allow farmers to manage projects themselves.

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References

Bulman P and Dalton G 2000, ‘Farm revegetation design – optimising your benefits’, Primary Industries and Resources SA.

Clean Energy Regulator 2022a, *Clean Energy regulator website*, Australian Government, accessed 20 August 2022, <https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Vegetation-methods/Reforestation-by-Environmental-or-Mallee-Plantings-FullCAM#:~:text=A%20reforestation%20by%20environmental%20or,or%20species%20of%20mallee%20eucalypts>.

Clean Energy Regulator 2022b, *Clean Energy regulator website*, Australian Government, accessed 20 August 2022, <https://www.cleanenergyregulator.gov.au/OSR/ANREU/types-of-emissions-units/australian-carbon-credit-units>

Clean Energy Regulator 2022c, *Clean Energy regulator website*, Australian Government, accessed 20 August 2022, <https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Vegetation-methods/Reforestation-by-Environmental-or-Mallee-Plantings-FullCAM/environmental-plantings-pilot>.

Clean Energy Regulator 2022d, *Clean Energy regulator website*, Australian Government, accessed 20 August 2022, <https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Risk-of-reversal-buffer>

Clean Energy Regulator 2022e, *Clean Energy regulator website*, Australian Government, accessed 20 August 2022, <https://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Permanence-obligations>.

Department of Climate Change, Energy, the Environment and Water 2022, *Department of Climate Change, Energy, the Environment and Water* website, Australian Government, accessed 20 August 2022, <https://www.dcceew.gov.au/climate-change/publications/full-carbon-accounting-model-fullcam>.

Gregory NG 1995, ‘The role of shelterbelts in protecting livestock: A review’, *New Zealand Journal of Agricultural Research*, vol. 38, no. 4, pp. 423–450.

Martin P 2021, ‘*Australia is about to be hit by a carbon tax whether the prime minister likes it or not, except the proceeds will go overseas. The Conversation, Australian Broadcasting Commission website*, accessed 20 August 2022, <https://theconversation.com/australia-is-about-to-be-hit-by-a-carbon-tax-whether-the-prime-minister-likes-it-or-not-except-the-proceeds-will-go-overseas-170959>.

Noble JC and Bradstock RA 1989, ‘Mediterranean Landscapes in Australia, Mallee ecosystems and their management’, CSIRO Publications Australia.

Primary Industries Climate Challenges Centre 2022, *Primary Industries Climate Challenges Centre website*, accessed 20 August 2022, <www.piccc.org.au/resources/tools>.

Summers DM, Regan C, Connor J and Cavagnaro TR 2019, *Assessing South Australian carbon offset supply and policy for co-beneficial offsets: Shelter belts for lamb mortality reduction.* Goyder Institute for Water Research Technical Report Series No. 19/08.

Weidemann S and Dunn J 2021, ‘V.SCS.0016 Carbon accounting technical manual’, MLA.

Weidemann S and Longworth E 2021, ‘Moving towards carbon neutrality – opportunities for the Australian feedlot industry’, MLA.

Western Australian Department of Agriculture and Food 2022, *Carbon calculators – Western Australian example farms’*, accessed 20 August 2022, <https://www.agric.wa.gov.au/carbon-calculators-western-australian-example-farms>.