Growing revenue using carbon shelterbelts

Case Study 2, Ashville

15 June 2022

Australian Government
Department of Agriculture, Water and the Environment

Future Drought Fund

Ai CARBON
Australian Integrated Carbon

Disclaimer

- *Australian Integrated Carbon Financial Services Pty Ltd ("AICFS" AFSL 425610) and its Authorised Representatives are authorised to provide financial services to wholesale clients as defined in the Corporations Act 2001 s761G.*

- *The information provided in this document is not an invitation to obtain a financial service, and should be considered as general advice only regarding the commercial characteristics of a carbon project of a specific size. It does not take into account any specific situation, and you should obtain your own advice.*

- *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.](https://Reputex.com)*

- *We accept no liability arising from the use of this document or its contents by you or third parties.*

- *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.*

- *AIC is one of the foundational signatories to the Code of Conduct for carbon projects. This Code provides confidence to customers that industry standards and transparency is upheld. The code can be viewed here: http://marketplace.carbonmarketinstitute.org/wp-content/uploads/2018/06/Australian-Carbon-Industry-Code-of-Conduct.pdf.*

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 in order 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 2 – Background

Case study 2 is a 6,500 ha mixed farm 30 km north east of Meningie in the Upper South East of SA. Average annual rainfall is 450 mm. Soils are well-drained sands and sandy loams over clay. The enterprise is based on a 3,400 ha cropping program including wheat, barley and hay crops, and a flock of 3,400 Merino ewes, joined to Merino and Border Leicester rams.

Major emphasis is being placed on soil improvement at present, with approx. 500 ha of the property being delved or spread with clay each year before going into crop. After claying and cropping, paddocks are sown to lucerne, with veldt grass tending to come back in lucerne paddocks over time.

The property is fenced into around 120 paddocks of 40 to 100 ha, and there are four significant stands of remnant vegetation totalling 100 ha.

The owners of the property are interested in shelterbelt plantings for the following reasons:

- stabilise light soils on top of sandhills
- extra shade and shelter, particularly for lambing ewes, in paddocks with few trees
- reduced windspeeds on the farm
- improved water use across the landscape to counter dryland salinity
- improved habitat for birds and wildlife as well as aesthetic appeal
- improved biosecurity from having shelterbelts on boundaries (effectively double fencing boundaries).

In addition to these 'on farm' priorities, the owners are aware they may need to offset greenhouse gas emissions in future for premium market access, and that there may be opportunities to generate income by sequestering carbon in shelterbelts. This will only be possible if shelterbelt design complies with an Australian Government carbon method.

3. Shelterbelt design

A theoretical shelterbelt design for the property is shown in Figure 1. Factors considered when designing the layout were:

- protection for lambing ewes from cold winds (usually from the south and west)
- planting along boundaries to improve biosecurity and reduce fencing costs
- planting on less productive country where possible
- creating a wildlife corridor between main patches of scrub.

The species chosen were 'mallee eucalypt species', since local mallee trees are drought and fire resistant (due to their lignotuber), maximise carbon yield, and are easier to establish than many shrubs (Noble and Bradstock 1989). Planting density was set at <1500 stems/ha.

Shelterbelts were designed to be 16 m wide, comprising 8 rows of trees 2.29 m apart. This design is consistent with the Reforestation by Environmental or Mallee Plantings Method. The total area allocated to shelterbelts was 163 ha, representing 2.5 % of the farm area.

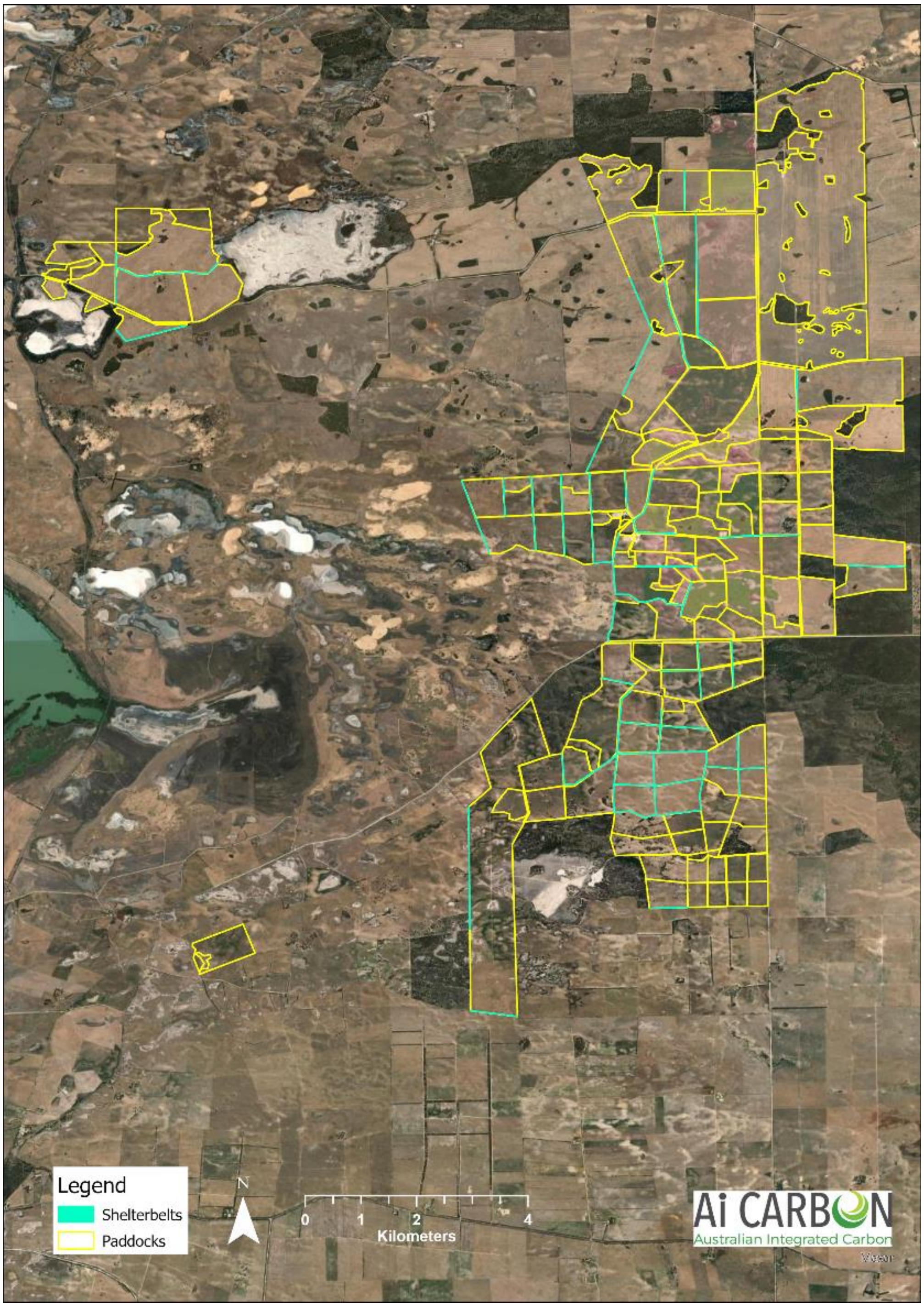

Fig. 1. Shelterbelt design on the 6,500 ha Ashville property, with proposed shelterbelts represented in green.

4. Cost of establishing shelterbelts

Cost estimates for establishing shelterbelts are shown in Table 1. Fencing costs for the 163 ha design were based on a contract rate of $5000/km for 53 km of Cyclone and steel post fencing ($265,000), and a cost of $1000/ha was allowed for site preparation and direct seeding 163 ha ($163,000). At these rates, the total cost of fencing and seeding would be $428,000. A figure of $27,000 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 163 ha
53 km fencing	$5000/km	$265,000
163 ha seeding	$1000/ha	$163,000
Post-seeding weed control, fence repairs		$27,000
Total		**$455,000**

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 $455,000. 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 randomly chosen locations on the property (see Figure 2 for example FullCAM curve). The four FullCAM yield curves were then converted to yield in CO_2e. The four curves showed some variation (Fig. 3) but a consistent pattern, with yields at their highest in years 3 to 10 (approx. 15-22 tCO_2e/ha/yr), dropping to 5-10 tCO_2e/ha/yr in later years.

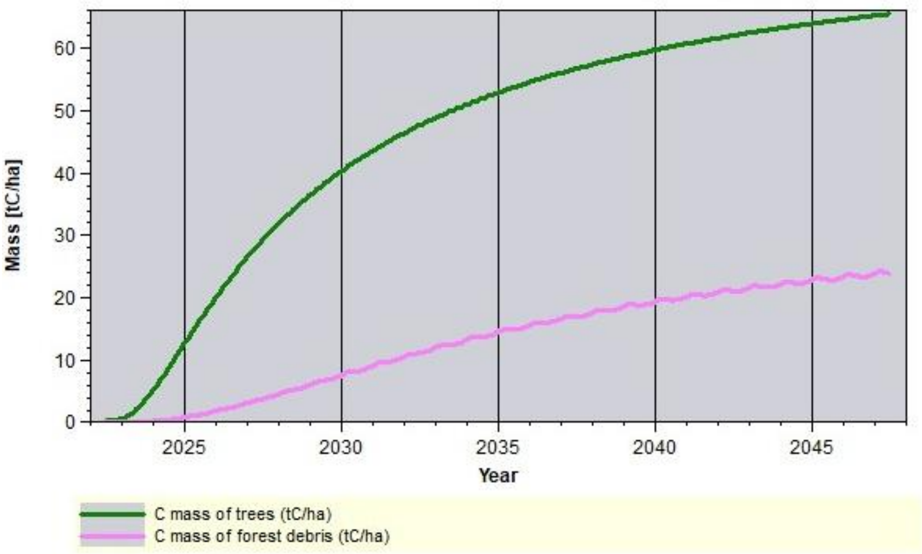

Fig. 2. FullCAM output from one site at Ashville showing cumulative carbon yield (tC/ha) over 25 years with mallee eucalyptus species planted in a belt at <1,500 stems/ha.

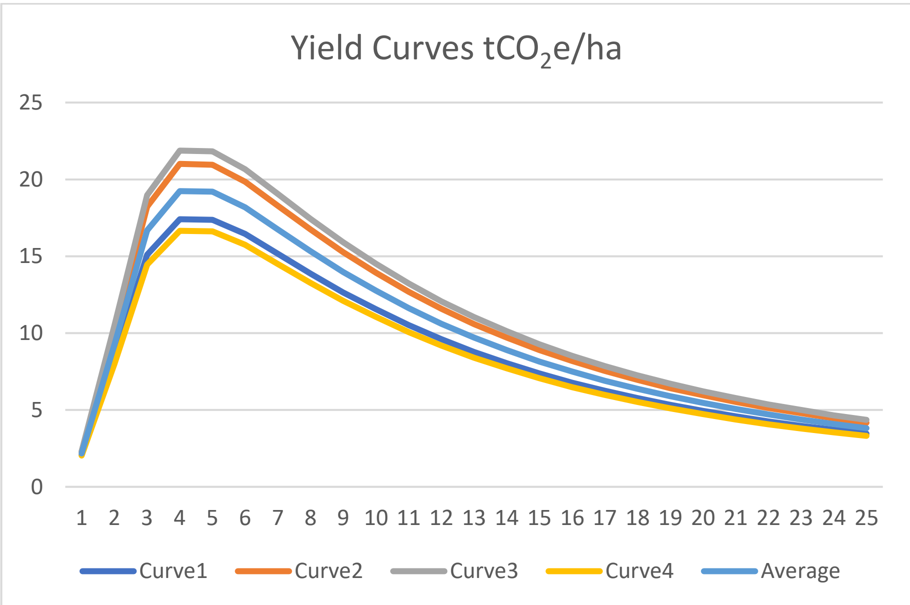

Fig. 3. Yield curves (t CO_2e/ha) at 4 different locations at Ashville over the 25 year project.

An average of the four curves was used to calculate project yields across 163 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 30,160 tCO_2e (Fig. 4), equating to 1,206 tCO_2e/yr (Fig. 5) or 7.4 tCO_2e/ha/yr.

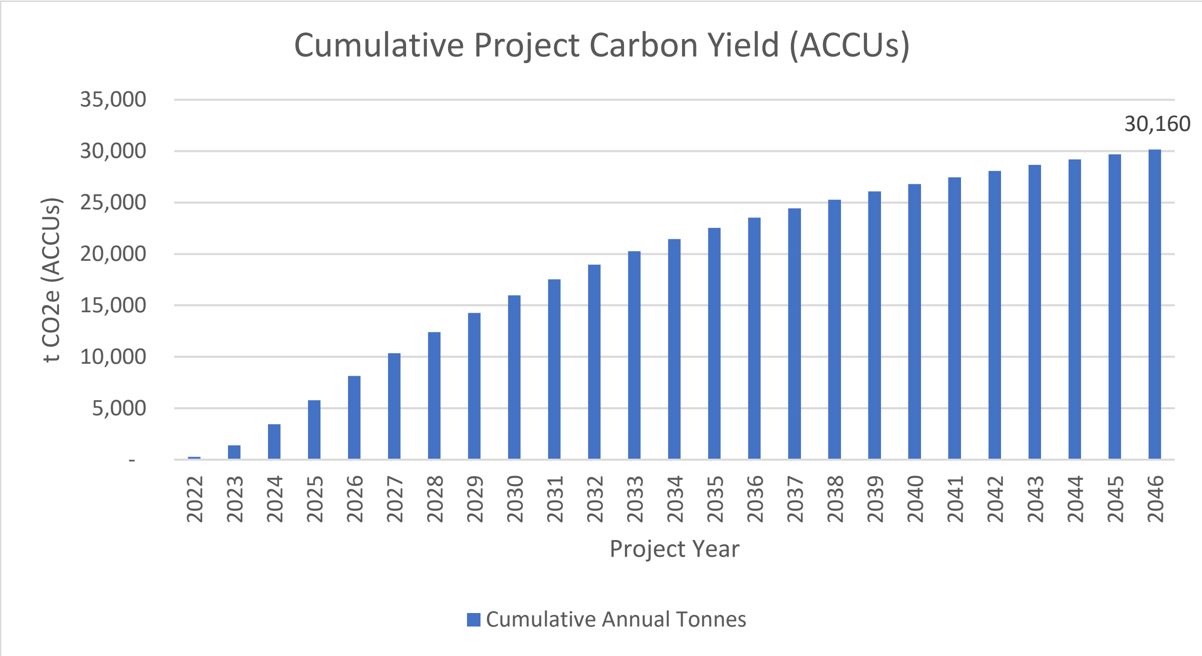

Fig. 4. Cumulative carbon yield from the 163 ha carbon estimation area at Ashville over 25 years.

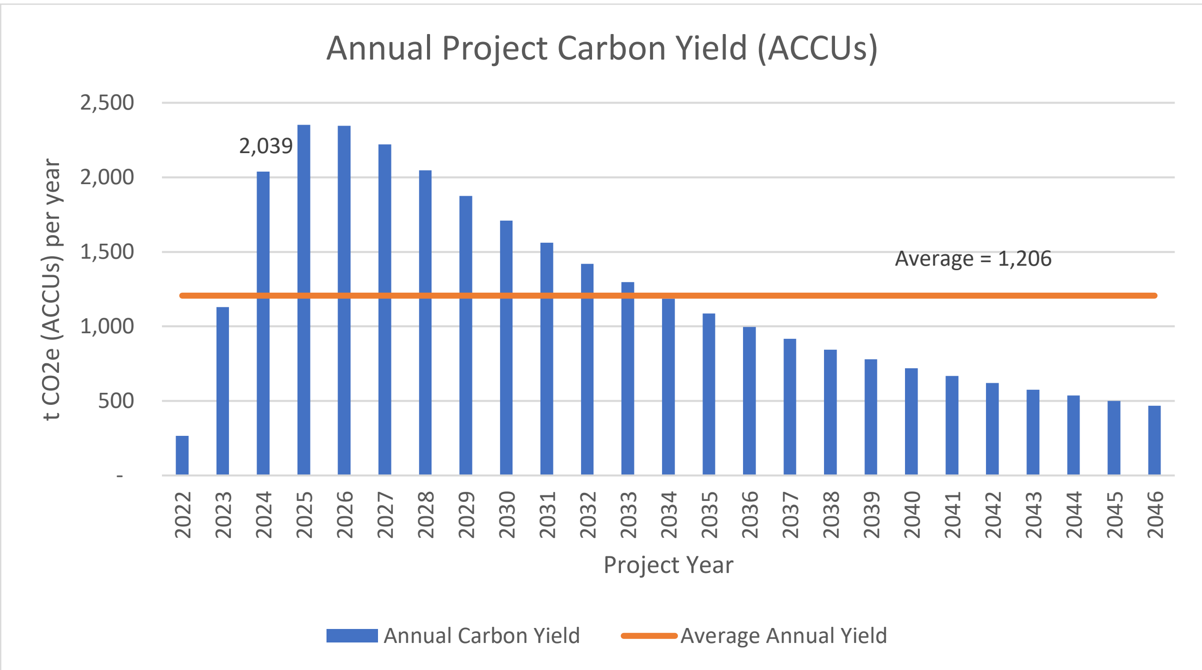

Fig. 5. Annual carbon yields (tCO_2e/yr) calculated from 4 different locations at Ashville over 25 years, and average annual yield across all years.

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 $46.69/t; the medium price was $35/t increasing to $71/t averaging $63.86/t; and the high scenario was $42 increasing to $105 averaging $93.49/t.

Revenues under the flat, low, base and high pricing scenarios totalled $523,000, $1.408m, $1.926m and $2.819m, respectively, and annual incomes of $21,000, $56,000, $77,000 and $113,000. Because annual carbon yields were at their highest in years 3 to 10, revenue was also greatest in those years ($35,000-$190,000/yr).

Table 2. Project revenue for the base 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 $46.69)	$35 to $71 (avg $63.86)	$42 to $105 (avg $93.49)
1	2022	265	$4,605	$8,493	$9,290	$11,148
2	2023	1,130	$19,613	$40,695	$47,478	$63,304
3	2024	2,039	$35,383	$79,536	$101,969	$144,796
4	2025	2,352	$40,801	$96,418	$126,990	$178,726
5	2026	2,346	$40,709	$98,547	$131,396	$192,401
6	2027	2,222	$38,551	$97,767	$135,541	$188,868
7	2028	2,048	$35,525	$92,141	$126,949	$190,424
8	2029	1,874	$32,519	$88,091	$125,576	$187,427
9	2030	1,710	$29,662	$83,771	$114,543	$174,380
10	2031	1,561	$27,082	$79,607	$110,826	$163,898
11	2032	1,420	$24,643	$72,439	$100,846	$149,139
12	2033	1,297	$22,499	$66,136	$92,072	$136,162
13	2034	1,186	$20,574	$60,476	$84,192	$124,510
14	2035	1,087	$18,867	$55,458	$77,207	$114,179
15	2036	997	$17,290	$50,824	$70,755	$104,637
16	2037	916	$15,898	$46,731	$65,057	$96,211
17	2038	844	$14,645	$43,050	$59,932	$88,632
18	2039	779	$13,520	$39,742	$55,327	$81,821
19	2040	720	$12,496	$36,732	$51,137	$75,625
20	2041	667	$11,577	$34,030	$47,376	$70,062
21	2042	619	$10,745	$31,585	$43,971	$65,027
22	2043	575	$9,981	$29,339	$40,845	$60,404
23	2044	536	$9,303	$27,345	$38,068	$56,298
24	2045	500	$8,679	$25,512	$35,517	$52,525
25	2046	467	$8,111	$23,841	$33,191	$49,085
Total		**30,160**	**$523,278**	**$1,408,305**	**$1,926,047**	**$2,819,686**
Average			**$20,931**	**$56,332**	**$77,042**	**$112,787**

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 $1.926m total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at $455,000, noting that costs could be greater in some landscapes or if consultants were employed.
- Carbon income was estimated to be $1.47m greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 4.2:1. Based on the revenue flows shown in Table 2, and assuming carbon was sold at the base rate, establishment costs would be recovered after 6 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 on the Ashville property may be improved lamb survival (Gregory 1995, Summers et al. 2019). A 4 % improvement in lamb survival per year could increase returns from lamb production by $24,000 per year, or $612,000 over 25 years, if stocking rates were maintained at current levels (3,400 ewes).
- 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	$455,000
Carbon revenue, base case	$1.926m
Potential profit	$1.47m
Ratio of revenue to establishment costs	4.2:1
Time until costs recovered	6 years
Possible value of extra lambs if lambing survival lifts 4 %	$612,000

7. *Offsetting farm emissions*

- Many farmers are more interested in offsetting their own emissions than selling ACCUs. 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, 0.7 tCO_2e/t oilseed, and 0.25 tCO_2e/t pulses (Western Australian Department of Agriculture and Food 2022) – which would equate to approx. 4800 t CO2e from cropping at the property. For the sheep enterprise, approx. 80 % of emissions would 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 3400 ewes producing 3400 lambs, the sheep likely produce another 1800 tCO_2e/yr.
- With the present project providing the opportunity to offset approx. 1,200 tCO_2e per year, the design would offset 18 % of farm emissions, potentially giving access to low carbon intensity markets in future.
- If premium markets became available in future for low carbon products, this could lead to substantial extra income (e.g., if lamb brought $8/kg instead of $7/kg, this would generate an extra $55,000/yr from 2,500 sales lambs with 22 kg carcase weight).
- To achieve carbon neutrality, the case study farm would need to pursue further abatement and offset strategies – for example, planting more trees, or through 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. *Perspective of the landholder*

- It is somewhat encouraging that the proposed shelterbelt design offers a way of offsetting 18 % of farm emissions without major negative impacts on production.
- The owners are also interested in the fact that carbon shelterbelts may enhance the economic performance of the farm if ACCUs are sold, as well as offer co-benefits such as improved animal welfare, landscape function and amenity.
- It is a major financial outlay to establish 163 ha of shelterbelts in one year, and a logistical challenge given lack of experience getting trees established. A project that gave the option of spreading establishment out over several years would be preferred.
- Access to grants from State or Federal Government that support tree planting or fencing, or 'green finance', would increase the chances of the project being established.

- The owners are aware that establishing shelterbelts will likely encounter some 'teething problems', such as establishment difficulty in dry years. More shelterbelts on the farm will also bring some negatives such as increased habitat for rabbits, foxes and kangaroos, but the owners believe these problems can be managed and are worth it for the extra habitat provided to other wildlife.
- The owners have spread clay on approx. 2000 ha of sandy soils on the property over the past 8 years, which has improved productivity and potentially soil carbon. Work is underway to quantify this soil carbon sequestration to assess its impact on net farm emissions.

9. Conclusions

- Using the base case pricing forecast, carbon revenue from shelterbelts was estimated to be 4.2 times the cost of establishment, with establishment costs recovered after 6 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.

Acknowledgements: This project was funded by the Australian Government's Future Drought Fund. Case study farmers are thanked for their assistance in the project.

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>.