Growing revenue using carbon shelterbelts

Case Study 1, Field

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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.*

- *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 are 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 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 1 – Background

Case Study 1 is a 694 ha sheep and beef property at Field, in the Coorong District Council around 35 km from Meningie. The enterprise runs Merino ewes joined to Border Leicester rams and trades cattle when season and opportunity allow.

Soils are well-drained sands and sandy loams over clay, and pastures are based on lucerne and veldt grass, with some cereal and rye grass planted for winter grazing and fodder. Average annual rainfall is approx. 450 mm. The property is fenced into 30 main paddocks, mostly 10 to 20 ha in size, and there are two significant stands of remnant vegetation totalling 50 ha. There is one area of the property where groundwater is within 30 cm of the surface and dryland salinity has started to appear.

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

- extra shelter for lambing ewes to boost lamb survival
- extra shade for sheep and cattle
- 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 arising from having shelterbelts on boundaries (effectively double fencing boundaries and reducing the risk of stock entering or leaving the property).

In addition to these 'on farm' priorities, the owner are mindful of the fact 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 design complies with an Australian Government carbon method.

3. Shelterbelt design

A theoretical shelterbelt design for Case Study 1 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
- provide a wildlife corridor between the two 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 24 m wide, allowing 5 rows of trees to be planted 4 m apart (the minimum spacing between rows) and keeping the outer rows 2 m from fences. This design is consistent with the Reforestation by Environmental or Mallee Plantings Method. The total area allocated to shelterbelts in the design was 53 ha, representing 7.6 % of the farm area.

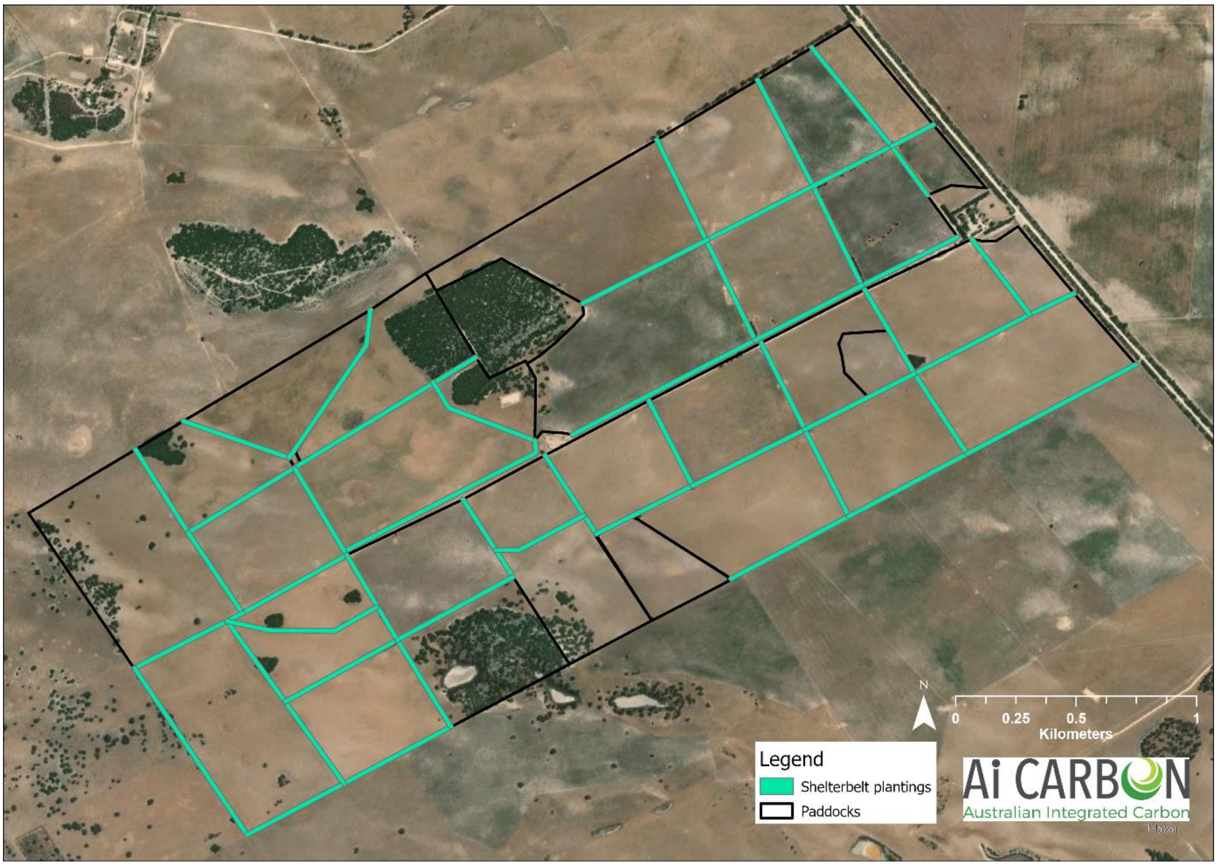

Fig. 1. Green lines indicate shelterbelt design on the 694 ha property.

4. *Cost of establishing shelterbelts*

Cost estimates for establishing shelterbelts are shown in Table 1. Fencing costs for the design shown in Figure 1 were based on a contract rate of $5000/km for 20 km of Cyclone and steel post fencing, and a cost of $1000/ha was allowed for site preparation and direct seeding 53 ha ($53,000). At these rates, the total cost of fencing and seeding would be $153,000. A figure of $7,000 was allowed for post-seeding weed control (spot spraying) and fence repairs over time.

Table 1. Cost estimates for shelterbelt establishment.

Item	Unit cost	Cost on 53 ha
20 km fencing	$5000/km	$100,000
53 ha seeding	$1000/ha	$53,000
Post-seeding weed control, fence repairs		$7,000
Total		**$160,000**

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 $160,000. 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 2 for example FullCAM curve). The four FullCAM yield curves were then converted to yield in CO_2e. These four curves were highly similar (Fig. 3), with yields highest in years 2 to 10 when trees grow fastest (approx. 15-25 $tCO_2e/ha/yr$), dropping to 5-15 $tCO_2e/ha/yr$ in later years.

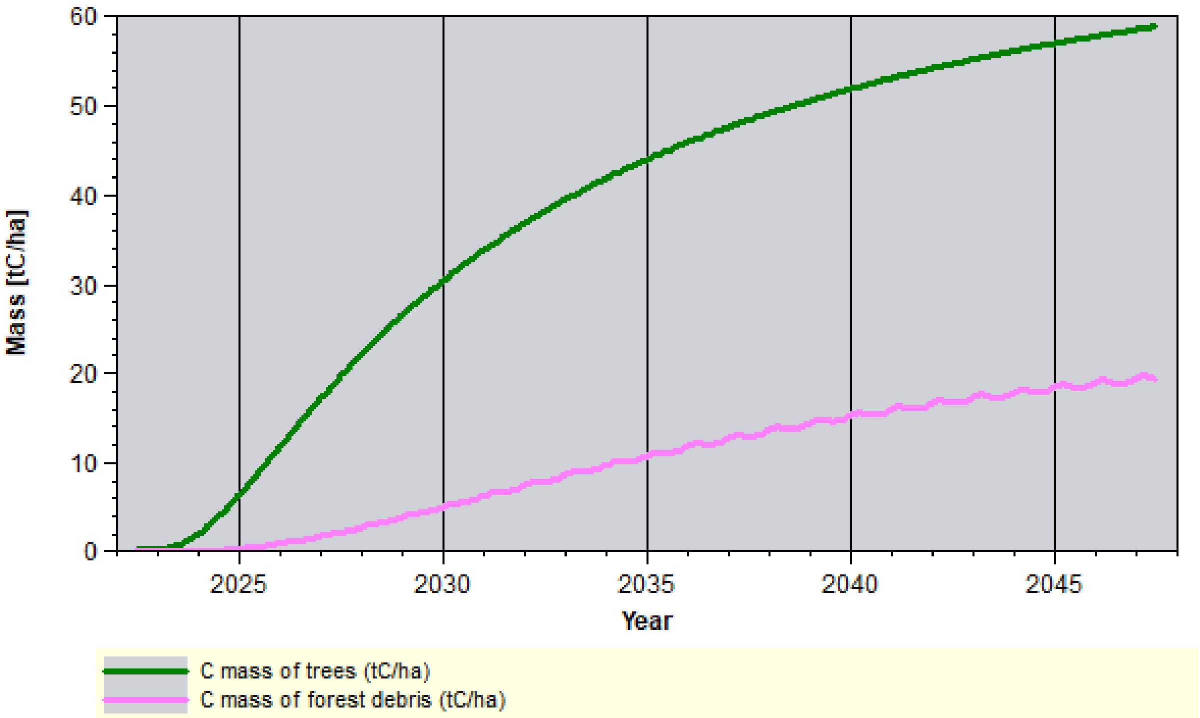

Fig. 2. FullCAM output from one site at Field showing cumulative carbon yield (tC/ha) over 25 years with mallee eucalyptus species planted in a belt at <1,500 stems/ha.

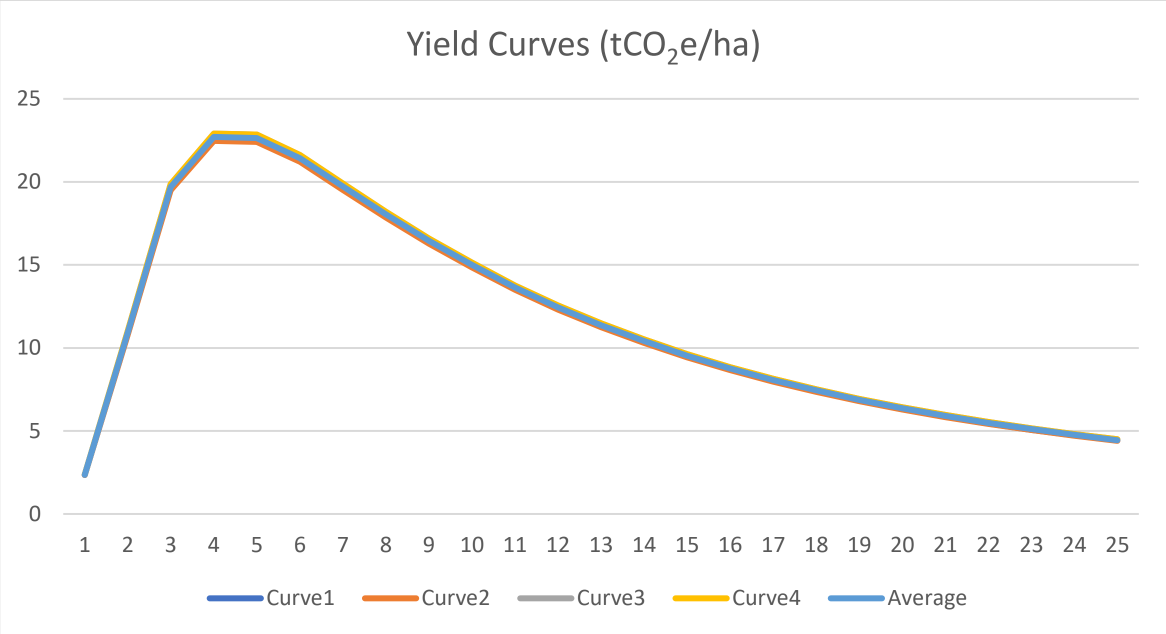

Fig. 3. Yield curves (tCO_2e/ha) at 4 different locations on the Field property over the 25 years of the project.

An average of the four curves was used to calculate project yields across 53 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 11,512 tCO_2e (Fig. 4), equating to 460 tCO_2e/yr (Fig. 5), or 8.7 $tCO_2e/ha/yr$.

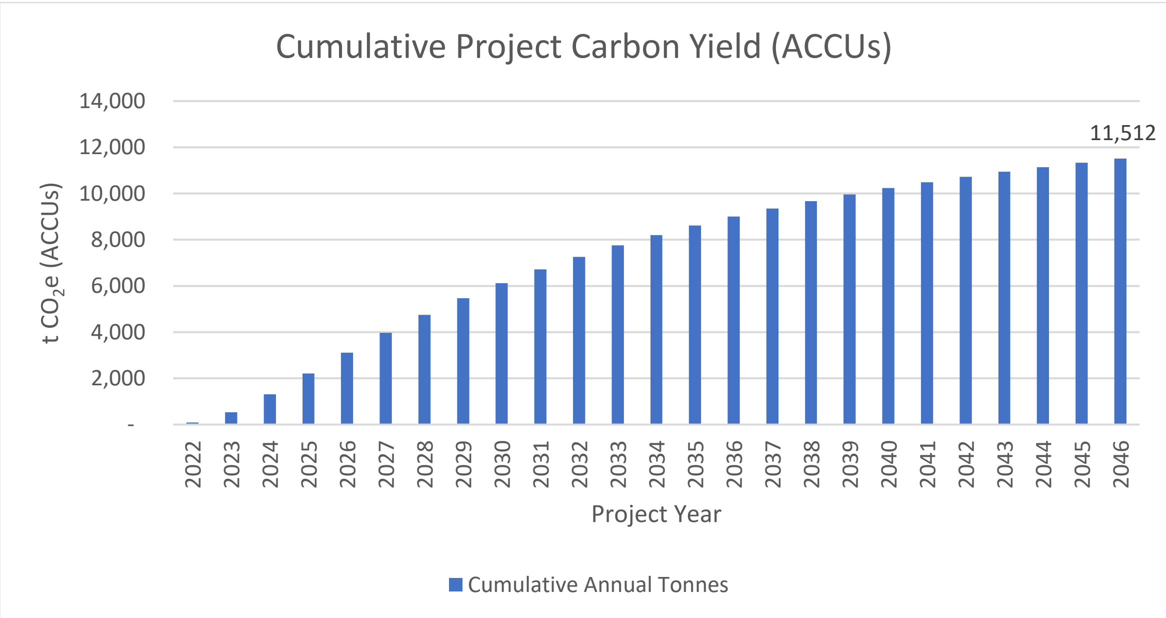

Fig. 4. Cumulative carbon yield from the 53 ha carbon estimation area at Field over 25 years.

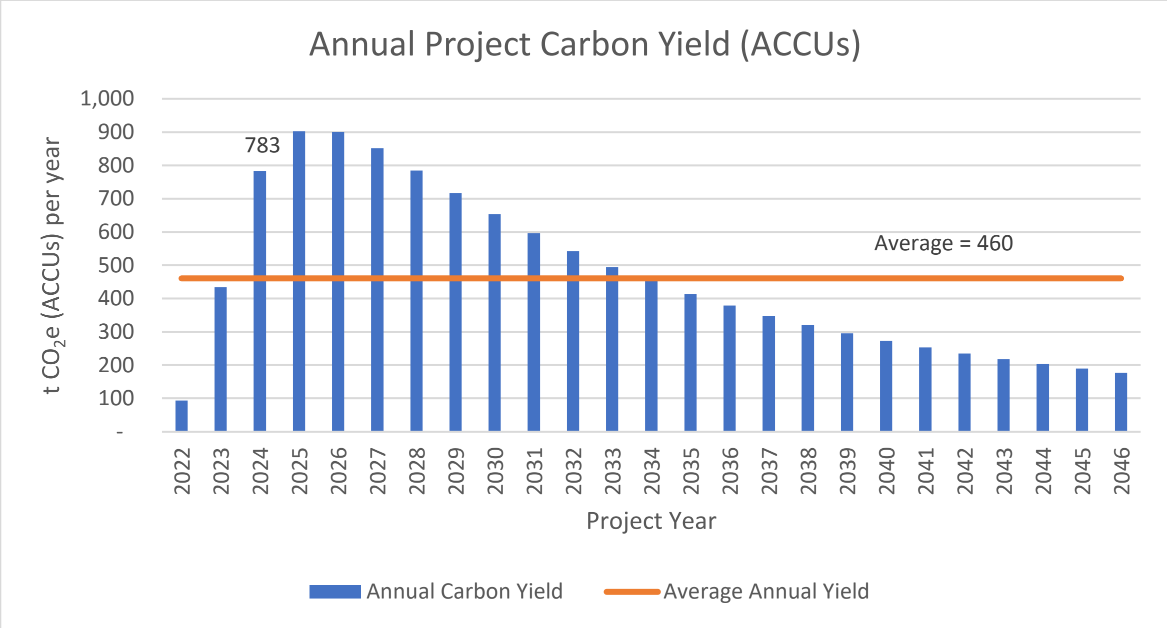

Fig. 5. Annual carbon yields (tCO_2e/yr) calculated from 4 different locations on the Field property over 25 years, and average annual yield across all years.

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 $63.85/t; and the high scenario was $42 increasing to $105 averaging $93.48/t.

Revenues under the flat, low, base and high pricing scenarios totalled $200,000, $537,000, $735,000 and $1.076m, respectively, and annual incomes of $8,000, $21,500, $29,400 and $43,000. Because annual carbon yields were at their highest in years 3 to 10, revenue was also greatest in those years ($13,000-$70,000/yr).

Table 2. Projected revenue from the Field Case Study 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 $63.85)	$42 to $105 (avg $93.48)
1	2022	94	$1,624	$2,995	$3,276	$3,931
2	2023	434	$7,528	$15,620	$18,223	$24,298
3	2024	783	$13,585	$30,537	$39,150	$55,593
4	2025	903	$15,662	$37,011	$48,746	$68,605
5	2026	900	$15,619	$37,811	$50,414	$73,821
6	2027	852	$14,782	$37,487	$51,971	$72,419
7	2028	784	$13,611	$35,302	$48,639	$72,958
8	2029	717	$12,448	$33,721	$48,070	$71,746
9	2030	654	$11,344	$32,037	$43,806	$66,690
10	2031	596	$10,347	$30,415	$42,343	$62,620
11	2032	542	$9,406	$27,650	$38,493	$56,926
12	2033	495	$8,580	$25,220	$35,111	$51,924
13	2034	452	$7,838	$23,041	$32,077	$47,438
14	2035	414	$7,182	$21,110	$29,389	$43,463
15	2036	379	$6,576	$19,331	$26,912	$39,800
16	2037	348	$6,042	$17,761	$24,726	$36,567
17	2038	321	$5,562	$16,351	$22,763	$33,663
18	2039	296	$5,131	$15,084	$20,999	$31,055
19	2040	273	$4,740	$13,934	$19,399	$28,688
20	2041	253	$4,389	$12,903	$17,962	$26,564
21	2042	235	$4,072	$11,970	$16,664	$24,643
22	2043	218	$3,781	$11,113	$15,471	$22,880
23	2044	203	$3,523	$10,355	$14,415	$21,318
24	2045	189	$3,285	$9,657	$13,445	$19,883
25	2046	177	$3,069	$9,022	$12,560	$18,575
Total		**11,512**	**$199,729**	**$537,438**	**$735,023**	**$1,076,067**
Average			**$7,989**	**$21,498**	**$29,401**	**$43,043**

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 $735,000 total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at $160,000, noting that costs could be greater in some landscapes or if consultants were employed.
- Carbon income was estimated to be $575,000 greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 4.6:1. Based on the revenue flows shown in Table 2, and assuming carbon was sold at the base rate establishment costs would be recovered after 5 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 Field 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 $10,800 per year, or $270,000 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	$160,000
Carbon revenue, base case	$735,000
Potential profit	$575,000
Ratio of revenue to establishment costs	4.6:1
Time until costs recovered	5 years
Possible value of extra lambs if lambing survival lifts 4 %	$270,000

7. Offsetting farm emissions

- Many farmers, including the owners of the Field property, 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 for most livestock properties, 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 1500 ewes producing 1500 lambs and 30 cows and calves and trading some steers, the enterprise probably produces approx. 800 t CO_2e/yr, with 700 tCO_2e/yr coming from enteric methane.
- With the present project providing an opportunity to offset 460 tCO_2e per year, the design would offset approx. 57 % of emissions each year, potentially giving access to low carbon intensity markets in future.

- If premium markets became available for low carbon products, this could lead to substantial extra income (e.g., if lamb brought $9/kg instead of $8/kg, this would generate an extra $24,000/yr from 1000 sales lambs with 24 kg carcase weight).
- To achieve carbon neutrality, the case study farm would likely need to pursue further abatement and offset strategies – for example, soil carbon sequestration, anti-methanogenic supplements, solar electricity generation, replacing some livestock with crops, or growing more trees. Alternatively, carbon credits could be purchased from carbon projects registered with the Clean Energy Regulator.

8. *Perspective of the landholder*

- The owners found it encouraging that the proposed shelterbelt design offers a way of offsetting a majority of farm emissions without major negative impacts on livestock 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 53 ha of shelterbelts in one year, and a logistical challenge given lack of experience getting trees established and variable rainfall. A project that enables trees to be established 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 through direct seeding can be difficult, and could fail in a dry year. More shelterbelts on the farm would 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.
- Finally, the owners of this case study property would also be open to using a mixture of block plantings and shelterbelt plantings. This would minimise fencing and allow trees to be located on least productive paddocks. Modelling block plantings rather than shelterbelt plantings is possible in FullCAM but yields less carbon than belt plantings due to extra competition between trees (see Case Study 3 in this series).

9. *Conclusions*

- Using the base case pricing forecast, carbon revenue from shelterbelts was estimated to be 4.6 times higher than the cost of establishment, with establishment costs recovered after 5 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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