Growing revenue using carbon shelterbelts

Case Study 5, Sedan

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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 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 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 5 - Background

Case study 5 is a 3,400 ha mixed farm near Sedan in the Murray Plains 70 km east of Adelaide. Average annual rainfall is approx. 290 mm, soils are mostly calcareous loams and sandy loams, and there are approx. 900 ha of remnant mallee woodland on the property.

The farming enterprise is based on a self-replacing flock of 650 Merino ewes joined to either Merino or South African Meat Merinos grazing annual and perennial pastures and shrubs including approx. 30 ha of planted saltbush. The property is at the margin of where cereal crops can be grown, and these are only grown opportunistically on approx. 250 ha if autumn and early winter rainfall is average or better. Crops have not been sown at all in the past two seasons. The property also derives income from the sale of specialty meat birds, with returns from this enterprise now approaching those from the sheep enterprise.

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

- return more vegetation to extensively cleared parts of the landscape
- provide extra shade and shelter for lambing ewes in paddocks with few trees
- reduced windspeeds
- improved habitat for birds and wildlife
- potential extra income from carbon sequestration in trees, and diversification of income in a marginal farming area.

In addition, the owners are also mindful of the fact there may in future be an opportunity to achieve premiums for meat and wool if they can demonstrate the farm has low net emissions.

3. Shelterbelt design

A theoretical shelterbelt design for the Sedan 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 preferred to improve biosecurity and reduce fencing costs
- prioritise plantings on less productive country with few trees
- provide wildlife corridor between patches of scrub where possible.

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 row 2 m from fences. This design is consistent with the Reforestation by Environmental or Mallee Plantings Method. The total area allocated to shelterbelts was 57 ha, representing 1.7 % of the farm area and 2.3 % of grazing or arable land.

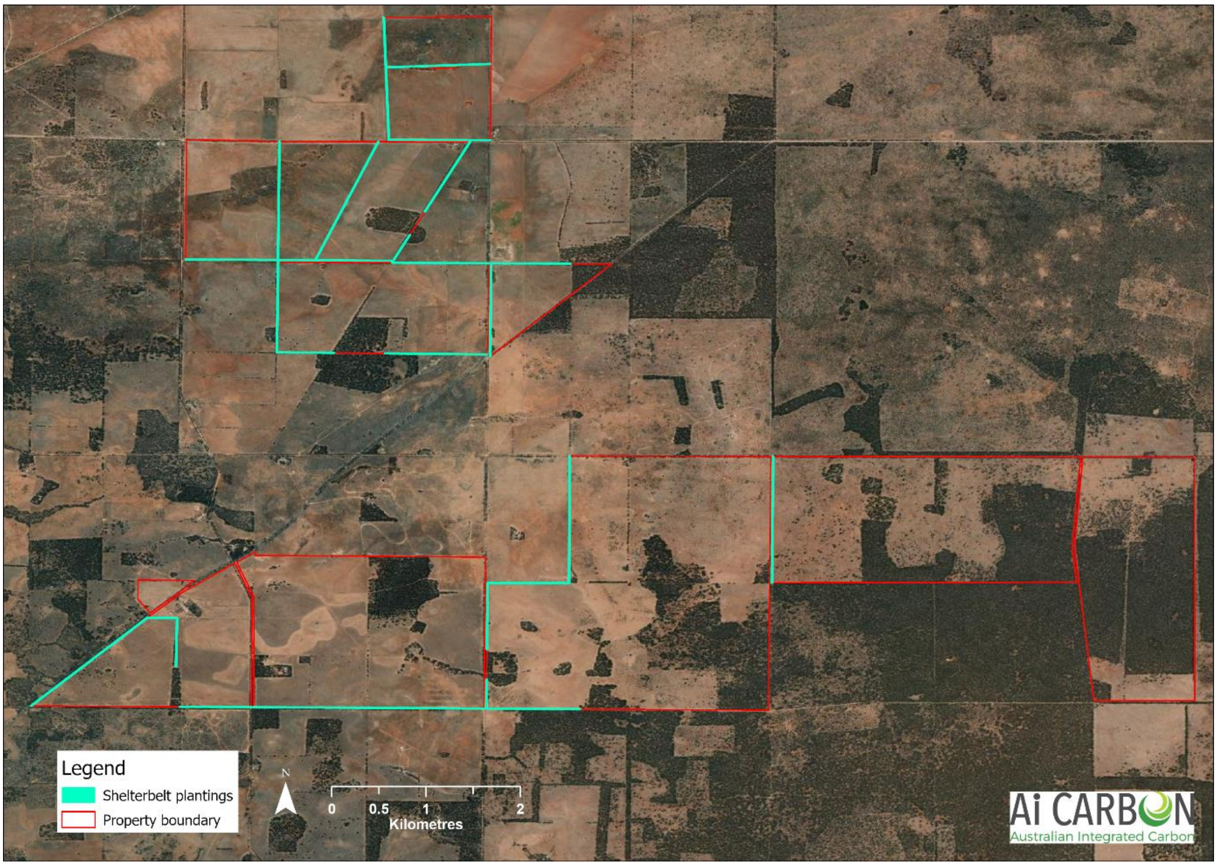

Fig. 1. Shelterbelt design on the 3,376 ha property near Sedan. Green lines indicate proposed shelterbelts.

4. Cost of establishing shelterbelts

Cost estimates for establishing shelterbelts are shown in Table 1. Fencing costs for the design were based on a contract rate of $5000/km for 25 km of Cyclone and steel post fencing ($125,000), and $1000/ha was allowed for site preparation and direct seeding 57 ha ($57,000). At these rates, the total cost of fencing and seeding would be $182,000. A figure of $7,000 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 57 ha
25 km fencing	$5000/km	$125,000
57 ha seeding	$1000/ha	$57,000
Post-seeding weed control, fence repairs		$7,000
Total		**$189,000**

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 $189,000 over 25 years. 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 3 to 10 when trees grow fastest (approx. 10-20 tCO_2e/ha/yr), dropping to 4-10 tCO_2e/ha/yr in later years.

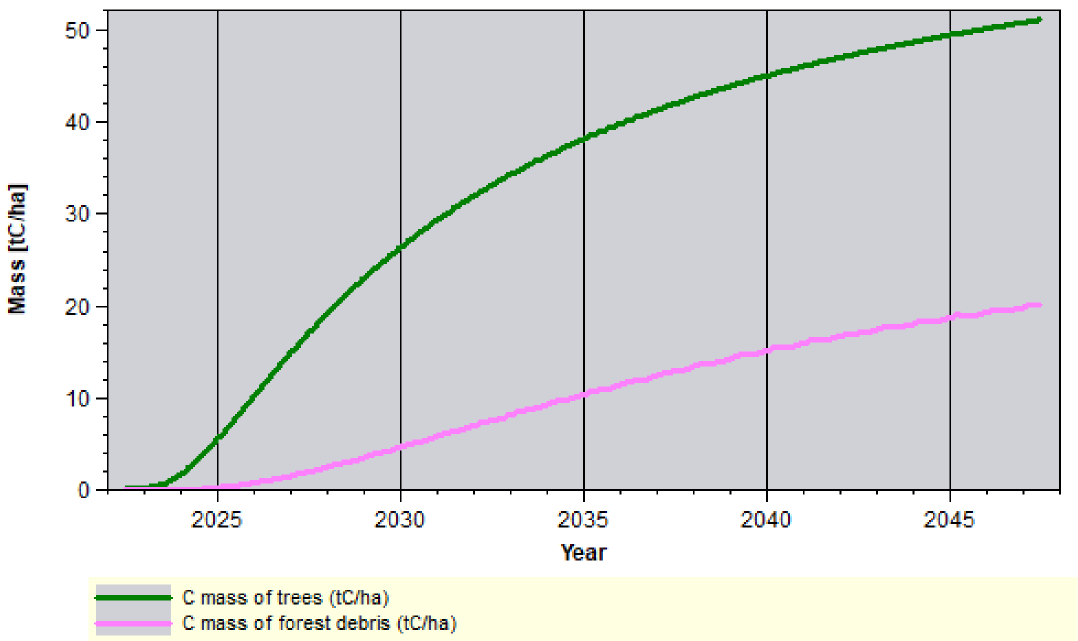

Fig. 2. FullCAM output from one site at Sedan showing cumulative carbon yield (tC/ha) over 25 years with mallee eucalyptus species planted in a belt at <1,500 stems/ha.

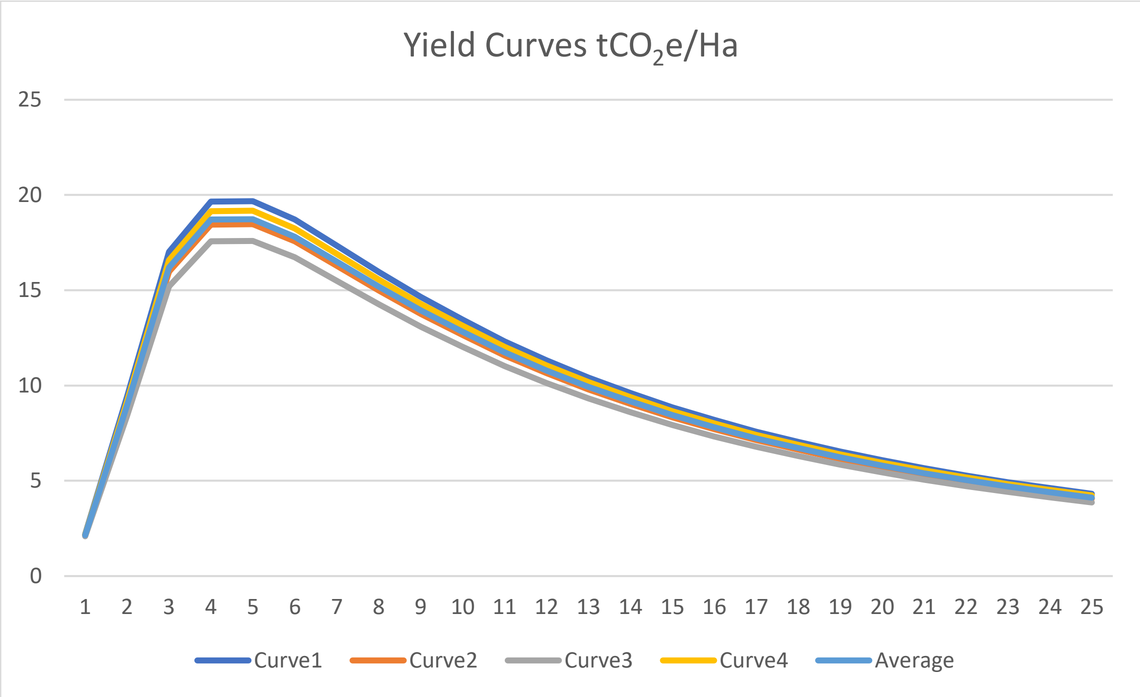

Fig. 3. Yield curves (tCO_2e/ha) at 4 different locations at Sedan over the 25 year project.

An average of the four curves was used to calculate project yield across 57 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 10,624 tCO_2e (Fig. 4), equating to 425 tCO_2e/yr (Fig. 5), or 7.5 tCO_2e/ha/yr.

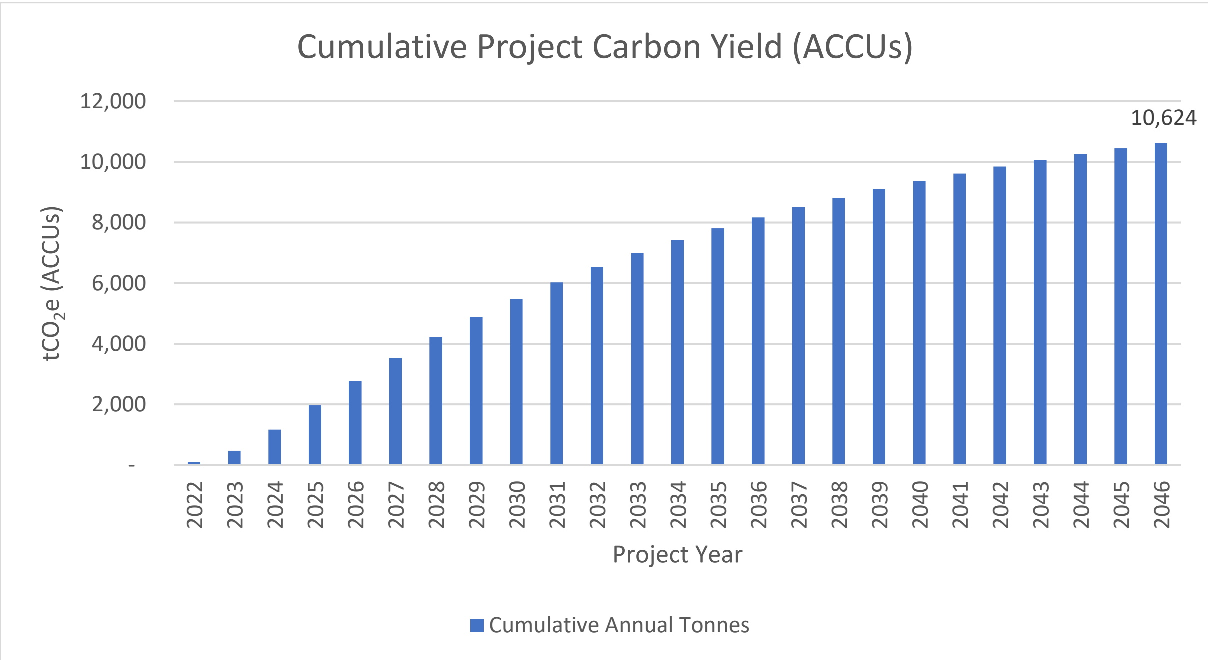

Fig. 4. Cumulative carbon yield from the 57 ha carbon estimation area at Sedan over 25 years.

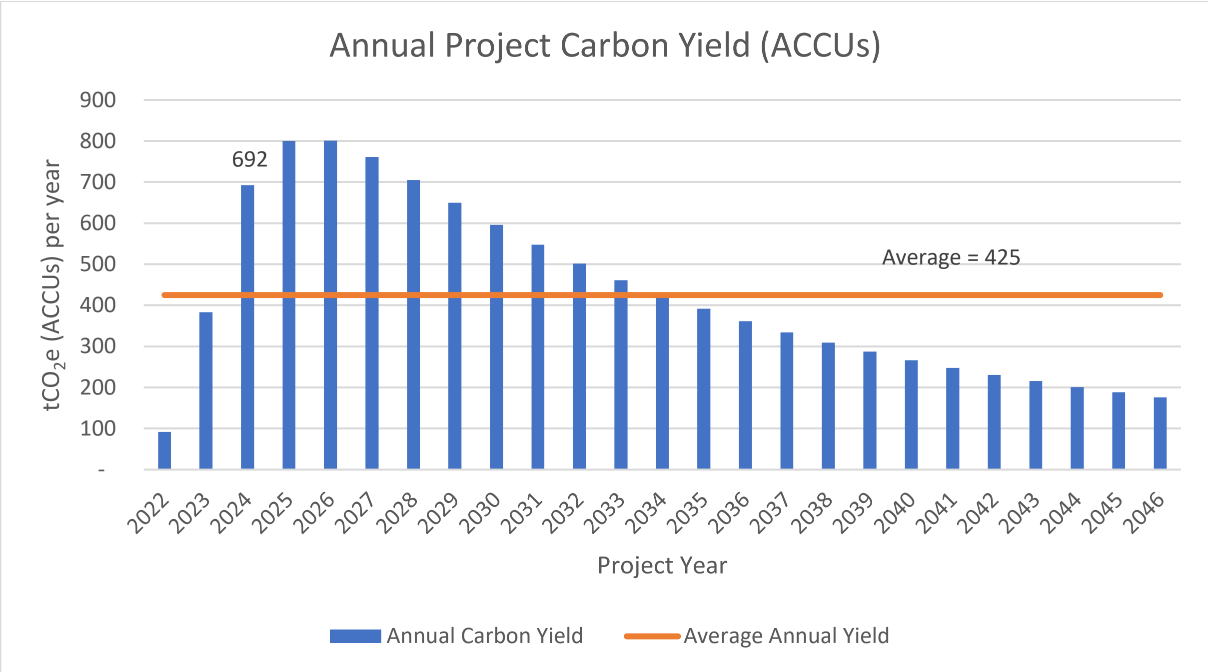

Fig. 5. Annual carbon yields (tCO_2e/yr) calculated from 4 different locations at Sedan over 25 years, and average annual yield across all years.

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 $64.08/t; and the high scenario was $42 increasing to $105 averaging $93.85/t.

Revenues under the flat, low, base and high pricing scenarios totalled $184,000, $497,000, $681,000 and $997,000, respectively, and annual incomes of $7,400, $19,900, $27,200 and $39,900. Because annual carbon yields were at their highest in years 3 to 10, revenue was also greatest in those years ($12,000-$65,000/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 $46.82)	$35 to $71 (avg $64.08)	$42 to $105 (avg $93.85)
1	2022	92	$1,592	$2,936	$3,211	$3,853
2	2023	383	$6,651	$13,800	$16,100	$21,466
3	2024	692	$12,011	$27,000	$34,615	$49,153
4	2025	800	$13,879	$32,797	$43,196	$60,794
5	2026	801	$13,891	$33,626	$44,835	$65,651
6	2027	761	$13,212	$33,505	$46,450	$64,725
7	2028	705	$12,236	$31,737	$43,726	$65,589
8	2029	649	$11,266	$30,519	$43,505	$64,933
9	2030	596	$10,341	$29,205	$39,933	$60,793
10	2031	548	$9,507	$27,944	$38,903	$57,533
11	2032	502	$8,706	$25,590	$35,626	$52,686
12	2033	461	$8,001	$23,518	$32,740	$48,419
13	2034	424	$7,363	$21,644	$30,132	$44,561
14	2035	392	$6,798	$19,984	$27,821	$41,143
15	2036	361	$6,264	$18,412	$25,632	$37,906
16	2037	334	$5,791	$17,023	$23,699	$35,048
17	2038	309	$5,363	$15,765	$21,947	$32,457
18	2039	287	$4,980	$14,640	$20,381	$30,140
19	2040	266	$4,619	$13,578	$18,903	$27,956
20	2041	248	$4,297	$12,632	$17,586	$26,007
21	2042	231	$4,004	$11,769	$16,384	$24,230
22	2043	215	$3,738	$10,987	$15,296	$22,621
23	2044	201	$3,489	$10,257	$14,279	$21,117
24	2045	188	$3,265	$9,597	$13,360	$19,758
25	2046	176	$3,059	$8,991	$12,518	$18,512
Total		**10,624**	**$184,322**	**$497,453**	**$680,775**	**$997,051**
Average			**$7,373**	**$19,898**	**$27,231**	**$39,882**

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 $681,000 total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at $189,000, noting that costs could be greater in some landscapes or if consultants were used.
- Carbon income was estimated to be $492,000 greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 3.6. 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 Sedan 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 $4,000 per year, or $110,000 over 25 years, if stocking rates were maintained at current levels (650 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	$189,000
Carbon revenue, base case	$681,000
Potential profit	$492,000
Ratio of revenue to establishment costs	3.6:1
Time until costs recovered	6 years
Possible value of extra lambs if lambing survival lifts 4 %	$110,000

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 Sedan property was beyond the scope of this study, but most grazing enterprises running 650 mature ewes emit approx. 300 tCO_2e/yr (see SB-GAF, Primary Industries Climate Challenges Centre 2022, and Weidemann and Dunn 2021). Cropping 250 ha with 1 t/ha cereal yields may emit another 75 tCO_2e/yr (see Western Australian Department of Agriculture and Food 2022), so the approx. carbon footprint is likely to be around 400 tCO_2e for the cropping and sheep businesses.
- With the present project offering a chance to offset around 400 tCO_2e/yr for 25 years, the proposed plantings would lead to approximate carbon neutrality, potentially allowing the enterprise to access premium markets in future.
- This could lead to substantial extra income (e.g., if lamb brought $9/kg instead of $7/kg, this would generate an extra $17,000/yr from 400 sales lambs with 22 kg carcase weight).
- A moderate increase in the project area may also allow generation of enough sequestration to offset emissions from the meat bird enterprise.

8. *Perspective of the landholder*

- It is encouraging that the proposed shelterbelt design offers a way of offsetting practically all farm emissions without major negative impacts on production.
- The managers are also interested in the fact that carbon shelterbelts may enhance farm economic performance 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 57 ha of shelterbelts in one year, and a logistical challenge given lack of experience getting trees established and the dry climate, particularly on heavy soils.
- 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.
- 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.

9. *Conclusions*

- Using the base case pricing forecast, carbon revenue from shelterbelts was estimated to be 3.6 times higher than 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.

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