



# Growing revenue using carbon shelterbelts

## Case Study 8, Sanderston

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**Australian Government**  
Department of Agriculture,  
Water and the Environment



Future  
Drought  
Fund

**Ai 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<sub>2e</sub> - the average price in the last ERF auction in April 2022*
  - *Low price \$32.00 - \$51.00/tCO<sub>2e</sub>*
  - *Base price \$35.00 - \$71.00/tCO<sub>2e</sub>, Compound Annual Growth (CAG) of 2.8 % over 25 years*
  - *High price \$42.00 - \$105.00/tCO<sub>2e</sub>, 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<sub>2</sub>e), with 1 tCO<sub>2</sub>e 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 8 – Background**

Case study 8 is a 2,600 ha cropping and sheep farm located near Sanderston, 70 km east of Adelaide. Average annual rainfall is approx. 300 mm, and soils are mostly loams and clay loams. The sheep enterprise is based on a self-replacing flock of 1,000 Merino ewes grazing annual pastures and cereals or vetch sown for sheep feed or hay. The cropping enterprise is based on around 2,000 ha of wheat and barley with smaller areas sown to canola. Over the



long term, cereal yields have averaged around 2-3 t/ha, though yields have been lower in recent years.

The managers at this farm are interested in shelterbelt plantings for the following reasons:

- return more vegetation to the landscape
- provide habitat for wildlife
- provide extra shade and shelter for sheep, particularly lambing ewes.

In addition, the managers are interested in the fact there could be an opportunity in future to earn extra income from carbon sequestration in trees, or achieve premiums for grain, meat and wool from a low emissions farm.

### **3. Shelterbelt design**

A shelterbelt design was developed for this case study that covered 50 ha of the 2,600 ha property (1.9 % of total farm area).

Factors considered when designing the layout were:

- protection for lambing ewes from cold winds (usually from the south and west)
- planting along existing fences preferred to improve biosecurity and reduce fencing costs
- provide a 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.

### **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 15 km of Cyclone and steel post fencing (\$75,000), and \$1000/ha was allowed for site preparation and direct seeding 50 ha (\$50,000). At these rates, the total cost of fencing and seeding would be \$125,000. A figure of \$10,000 was allowed for post-seeding weed control (spot spraying) and for fence repairs over time.



**Table 1. Cost estimates for shelterbelt establishment.**

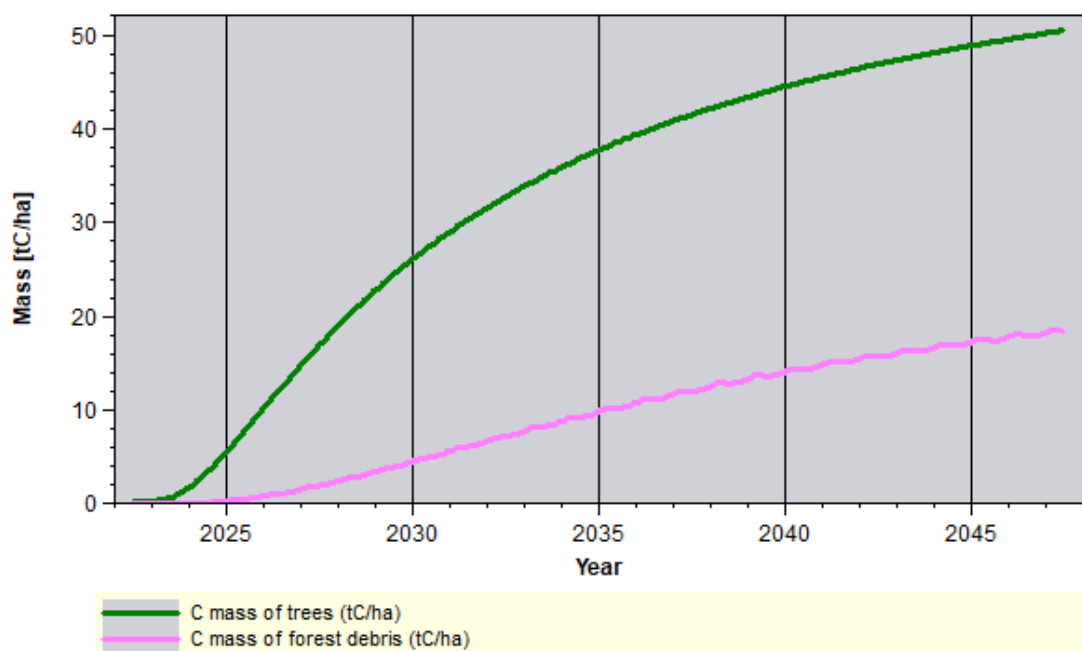
Item	Unit cost	Cost on 50 ha
15 km fencing	\$5000/km	\$75,000
50 ha seeding	\$1000/ha	\$50,000
Post-seeding weed control, fence repairs		\$10,000
<b>Total</b>		<b>\$135,000</b>

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.

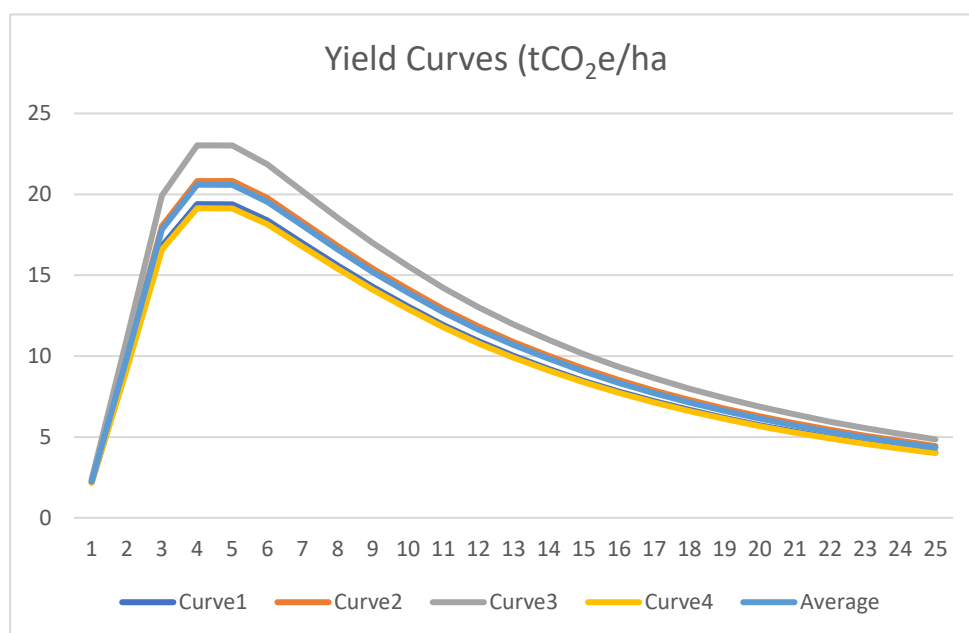
The total cost of establishing the project was thus estimated at \$135,000 over 25 years. These cost estimates are a guide and will change depending on soil, slopes, condition of pastures and weeds.

### **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 1 for example FullCAM curve). The four FullCAM yield curves were then converted to yield in CO<sub>2</sub>e. These four curves were similar (Fig. 2), with yields highest in years 3 to 10 when trees grow fastest (approx. 10-20 tCO<sub>2</sub>e/ha/yr), dropping to 4-12 tCO<sub>2</sub>e/ha/yr in later years.



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

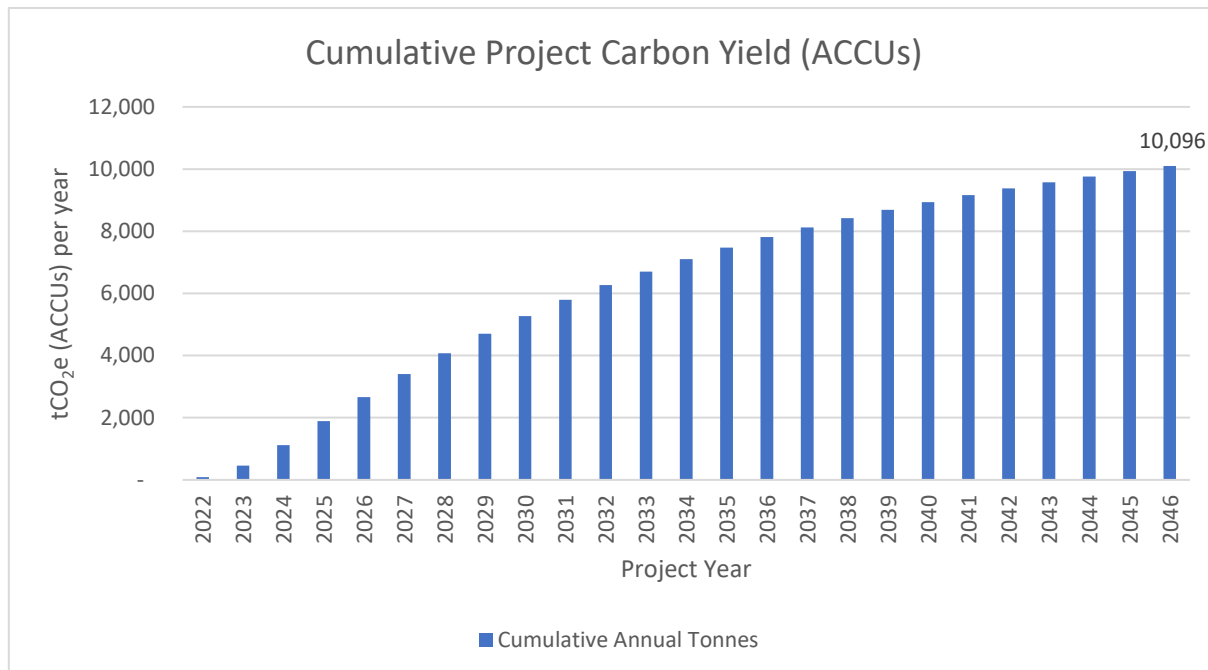


**Fig. 2. Yield curves (tCO<sub>2</sub>e/ha) at 4 different locations near Sanderston over the 25 years of the project.**

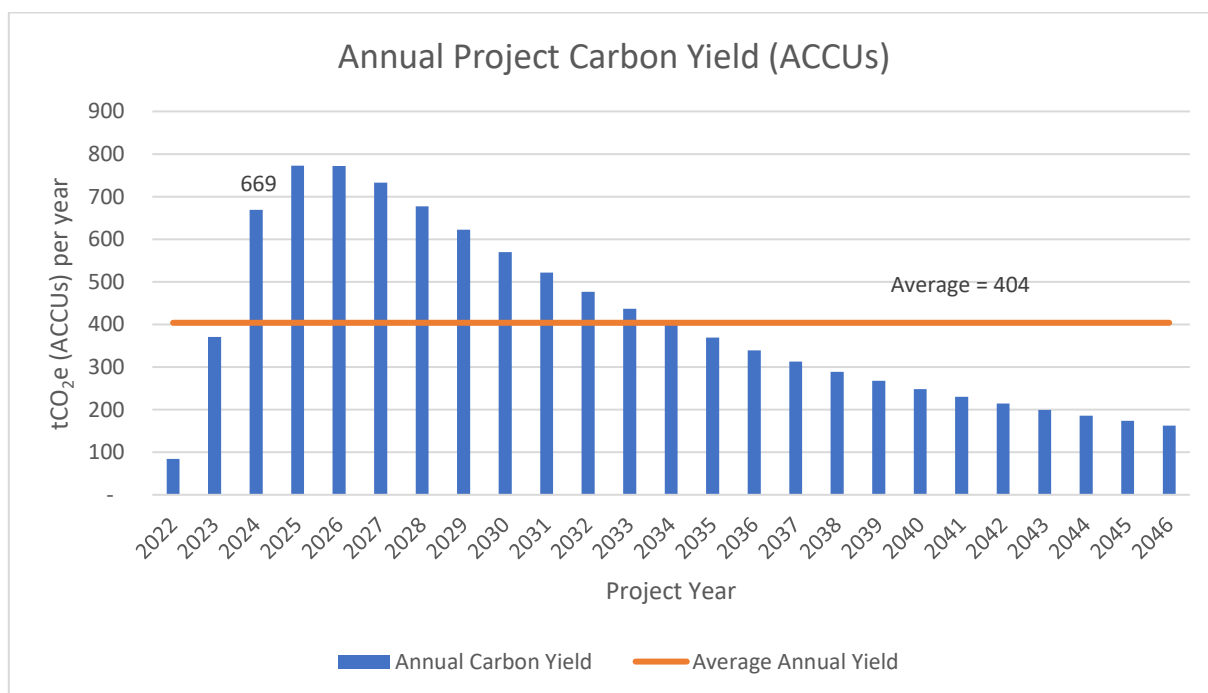
An average of the four curves was used to calculate project yield across 50 ha. These calculations included the 25 % yield reductions applied to 25 year vegetation projects (5 % risk reversal buffer and 20 % permanence buffer, Clean Energy Regulator 2022d, 2022e).



Cumulative project yield was estimated to be 10,096 tCO<sub>2</sub>e (Fig. 3), equating to 404 tCO<sub>2</sub>e/yr (Fig. 4), or 8.1 t tCO<sub>2</sub>e/ha/yr.



**Fig. 3. Cumulative carbon yield from the 50 ha carbon estimation area at Sanderston over 25 years.**



**Fig. 4. Annual carbon yields (tCO<sub>2</sub>e/yr) calculated from 4 different locations at Sanderston 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 \$175,000, \$472,000, \$646,000 and \$946,000, respectively, and annual incomes of \$7,000, \$18,900, \$25,800 and \$37,800. Because annual carbon yields were at their highest in years 3 to 10, revenue was also greatest in those years (\$11,000-\$63,000/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 \$63.85)	\$42 to \$105 (avg \$93.48)
1	2022	84	\$1,460	\$2,694	\$2,946	\$3,535
2	2023	370	\$6,427	\$13,335	\$15,558	\$20,744
3	2024	669	\$11,605	\$26,087	\$33,445	\$47,492
4	2025	772	\$13,399	\$31,664	\$41,704	\$58,694
5	2026	772	\$13,394	\$32,423	\$43,231	\$63,302
6	2027	733	\$12,715	\$32,247	\$44,705	\$62,294
7	2028	677	\$11,752	\$30,480	\$41,995	\$62,992
8	2029	622	\$10,793	\$29,237	\$41,679	\$62,207
9	2030	569	\$9,880	\$27,903	\$38,153	\$58,084
10	2031	522	\$9,055	\$26,618	\$37,056	\$54,801
11	2032	477	\$8,270	\$24,309	\$33,842	\$50,048
12	2033	437	\$7,578	\$22,276	\$31,011	\$45,861
13	2034	401	\$6,954	\$20,442	\$28,459	\$42,087
14	2035	369	\$6,401	\$18,815	\$26,194	\$38,737
15	2036	339	\$5,884	\$17,295	\$24,077	\$35,607
16	2037	313	\$5,426	\$15,950	\$22,206	\$32,839
17	2038	289	\$5,013	\$14,736	\$20,514	\$30,338
18	2039	268	\$4,642	\$13,645	\$18,996	\$28,093
19	2040	248	\$4,299	\$12,637	\$17,593	\$26,018
20	2041	230	\$3,992	\$11,734	\$16,335	\$24,157
21	2042	214	\$3,712	\$10,912	\$15,191	\$22,466
22	2043	199	\$3,457	\$10,162	\$14,147	\$20,922
23	2044	186	\$3,225	\$9,480	\$13,198	\$19,519
24	2045	174	\$3,014	\$8,858	\$12,332	\$18,237
25	2046	163	\$2,820	\$8,289	\$11,540	\$17,066
<b>Total</b>		<b>10,096</b>	<b>\$175,168</b>	<b>\$472,228</b>	<b>\$646,107</b>	<b>\$946,142</b>
<b>Average</b>			<b>\$7,007</b>	<b>\$18,889</b>	<b>\$25,844</b>	<b>\$37,846</b>





## 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 \$646,000 total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at \$135,000, noting that costs could be greater in some landscapes or if consultants were used.
- Carbon income was estimated to be \$511,000 greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 4.8:1. 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 Sanderston 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 \$6,000 per year (40 lambs @ \$150), or \$150,000 over 25 years, if stocking rates were maintained at current levels (1000 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	\$135,000
Carbon revenue, base case	\$646,000
Potential profit	\$511,000
Ratio of revenue to establishment costs	4.8:1
Time until costs recovered	5 years
Possible value of extra lambs if lambing survival lifts 4 %	\$150,000



## 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<sub>2</sub>e per tonne of cereal grain and 0.7 tCO<sub>2</sub>e/t oilseeds (Western Australian Department of Agriculture and Food 2022). On this farm, cropping emissions probably total approx. 1,500 tCO<sub>2</sub>e in an average year. 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 1,000 ewes producing 1,000 lambs, the sheep likely produce another 450 tCO<sub>2</sub>e/yr.
- With the present project offering the opportunity to offset 404 tCO<sub>2</sub>e each year, the proposed shelterbelts would offset 21 % of farm emissions, potentially allowing the enterprise to access 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 \$8/kg instead of \$7/kg, this would generate an extra \$14,000/yr from 700 sales lambs with 20 kg carcass weight).
- To achieve carbon neutrality, the farm would likely need 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 find it encouraging that the proposed shelterbelt design offers a way of offsetting 21 % of farm emissions without major negative impacts on production.
- The owners are also interested in the fact 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 50 ha of shelterbelts in one year, and a logistical challenge given lack of experience direct seeding trees.
- The owners are aware that establishing shelterbelts through direct seeding can be difficult, and could fail in a dry year.
- Access to grants from State or Federal Governments, or other organisations that support tree planting or fencing would increase the chances of the project being established.



## 9. Conclusions

- Using the base case pricing forecast, carbon revenue from shelterbelts was estimated to be 4.8 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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