Growing revenue using carbon shelterbelts

Case Study 10, Loxton

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- *This report provides pricing scenarios to help understand potential revenue returns. We use four pricing scenarios:*
    - *Auction price of $17.35/tCO$_2$e - the average price in the last ERF auction in April 2022*
    - *Low price $32.00 - $51.00/tCO$_2$e*
    - *Base price $35.00 - $71.00/tCO$_2$e, Compound Annual Growth (CAG) of 2.8 % over 25 years*
    - *High price $42.00 - $105.00/tCO$_2$e, 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 10 – Background

The Loxton district is approx. 250 km east of Adelaide in the South Australia's Riverland. Average annual rainfall is 263 mm and the region has predominately sandy soils. The region's economy is underpinned by irrigated citrus and grape vines crops, with other fruits, vegetables and nut crops also grown.

Though the horticulture sector was not an initial target of this series of case studies, there are several reasons why carbon shelterbelts may be of interest in the sector – horticultural plantings often have adjacent unplanted land, and can still benefit from some shelterbelt co-benefits. There is also the potential for revenue from carbon shelterbelts, and there may be market benefits associated with generating local carbon offsets and producing a low emissions product.

This case study focusses on a 135 ha apple orchard near Loxton, exploring the economics of carbon plantings at Loxton and possible impact on net emissions for the orchard.

3. *Plantation design*

There is minimal space available for wide linear plantings in the current apple orchard planting. However, for the purposes of this study it is assumed two corners of the property totalling 50 ha could be planted in a block planting design. Because the orchard owners are interested in maximising both conservation and biodiversity outcomes, local environmental species would be the preferred planting type. Given the scale of the project, direct seeding is considered the most appropriate approach to establishment.

4. *Cost of establishing shelterbelts*

Cost estimates for establishing shelterbelts are shown in Table 1. Fencing costs for 50 ha of block plantings were based on a contract rate of $5000/km for 10 km of Cyclone and steel post fencing ($50,000), and $1000/ha was also allowed for site preparation and direct seeding 50 ha ($50,000). At these rates, the total cost of fencing and seeding would be $100,000. 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**
10 km fencing	$5000/km	$50,000
50 ha seeding	$1000/ha	$50,000
Post-seeding weed control, fence repairs		$10,000
Total		**$110,000**

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 $110,000. 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 over a 25 year period (see Fig. 1 for an example yield curve) at four randomly chosen locations within the block planting design. The four FullCAM yield curves were then converted to yield in CO_2e. The four curves were similar (Fig. 2), with yields highest in years 4 to 12 when trees grow fastest (5-8 tCO_2e/ha/yr), dropping to 3-6 tCO_2e/ha/yr in later years.

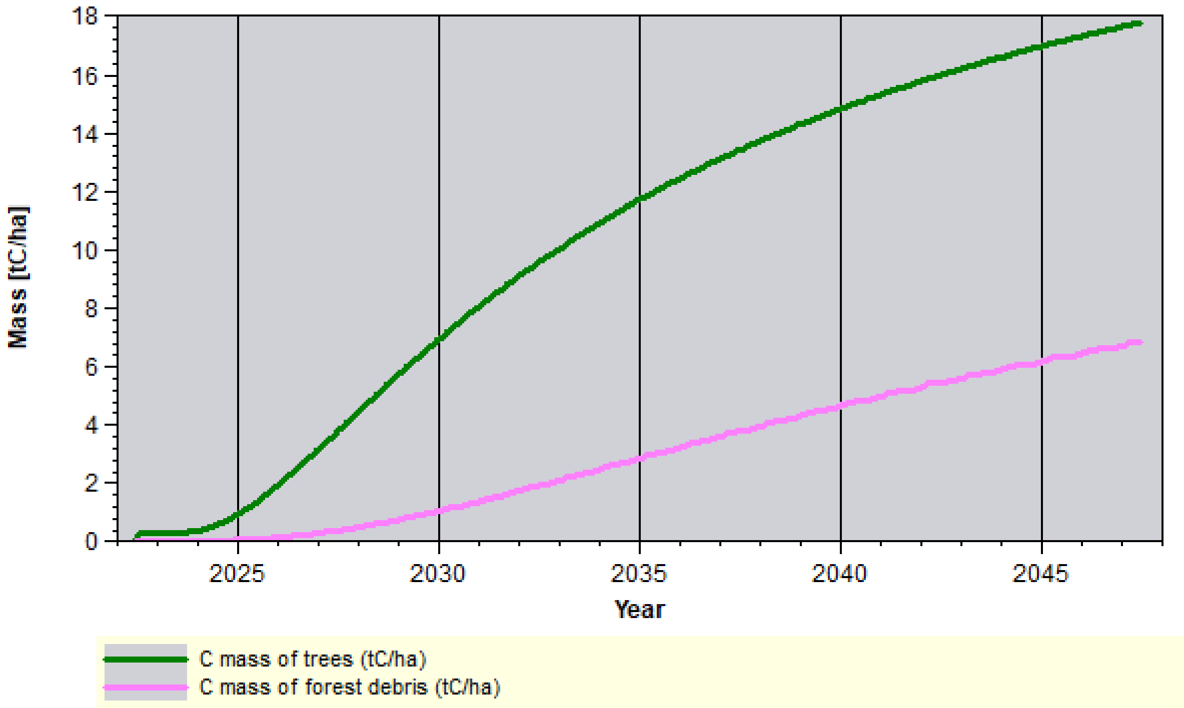

Fig. 1. FullCAM output from one site at Loxton showing cumulative carbon yield (tC/ha) over 25 years with mixed environmental plantings in a block.

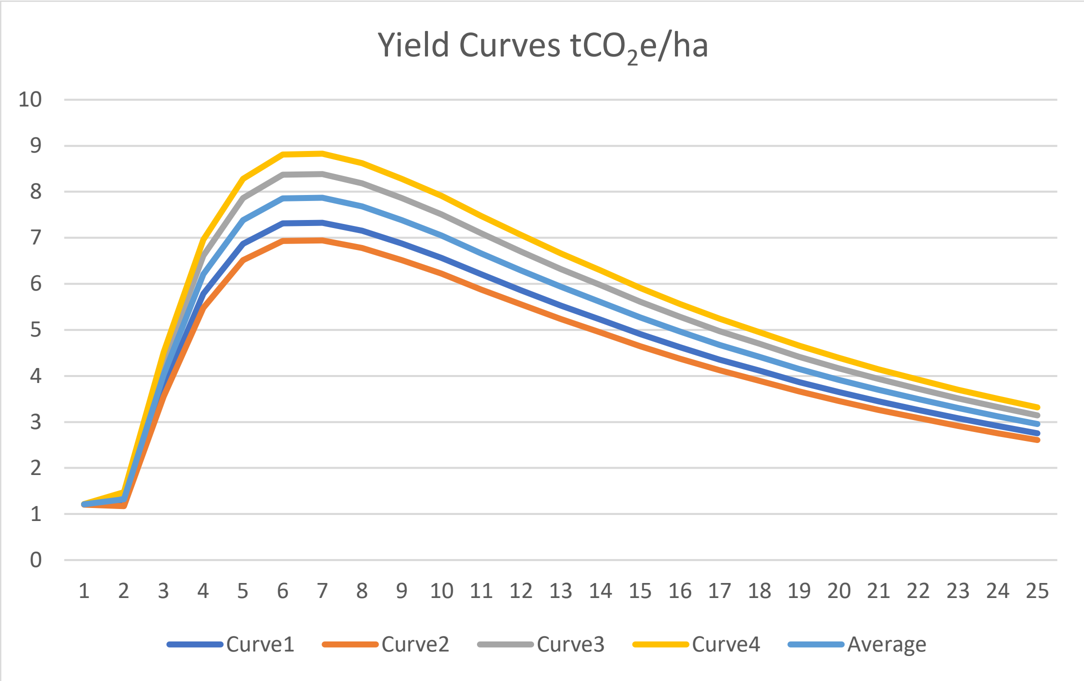

Fig. 2. Yield curves (tCO_2e/ha) at 4 different locations near Loxton over the 25 years.

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 4,742 tCO_2e (Fig. 3), equating to 190 tCO_2e/yr (Fig. 4), or 3.8 tCO_2e/ha/yr.

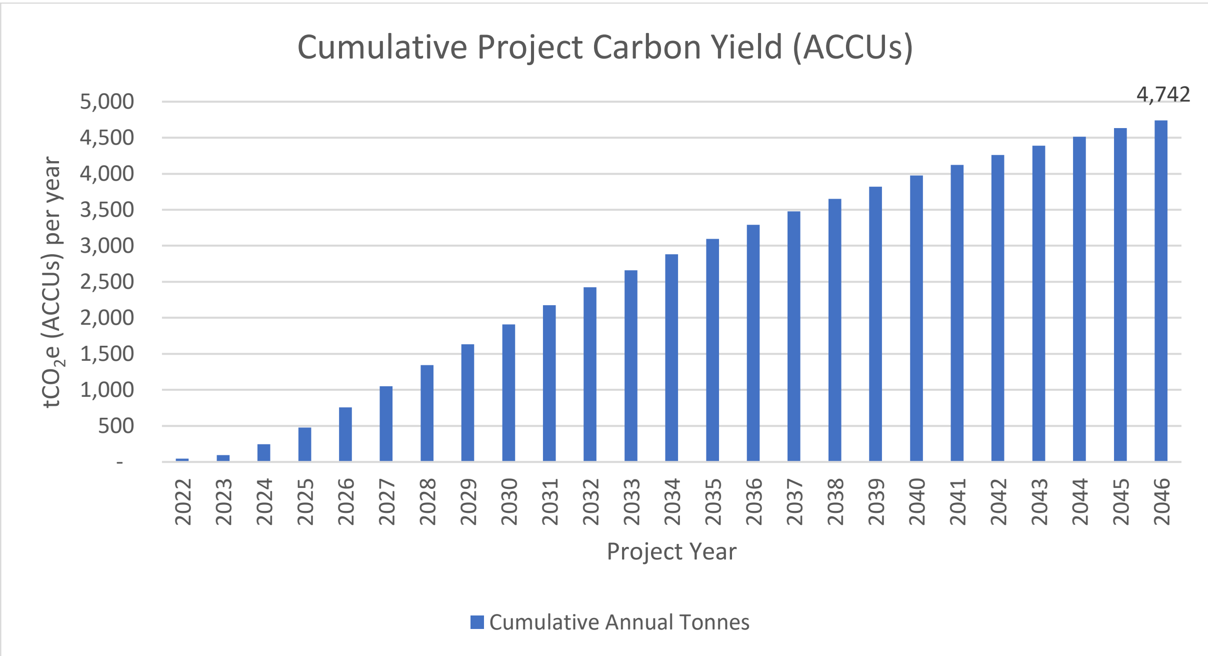

Fig. 3. Cumulative carbon yield from the 50 ha carbon estimation area at Loxton over 25 years.

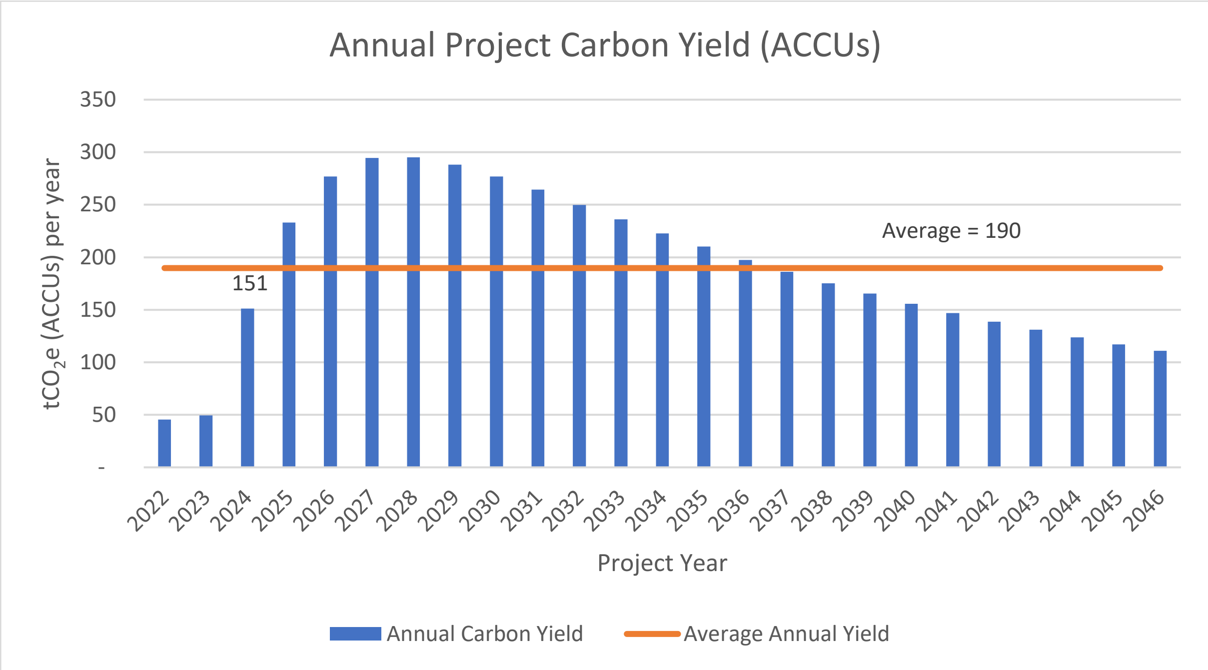

Fig. 4. Annual carbon yields (tCO_2e/yr) calculated from 4 different locations at Loxton over 25 years, and average annual yield across all years.

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)](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 $48.09/t; the medium price was $35/t increasing to $71/t averaging $66.32/t; and the high scenario was $42 increasing to $105 averaging $97.57/t.

Revenues under the flat, low, base and high pricing scenarios totalled $82,000, $228,000, $314,000 and $463,000, respectively, and annual incomes of $3,300, $9,100, $12,600 and $18,500. Because annual carbon yields were at their highest in years 4 to 12, revenue was also greatest in those years ($4,000-$29,000/yr).

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

Yr	Calendar	Annual Tonnes	Auction Scenario	Low Scenario	Base Scenario	High Scenario
			Flat $17.35	$32 to $51 (avg $48.09)	$35 to $71 (avg $66.32)	$42 to $105 (avg $97.57)
1	2022	45	$788	$1,454	$1,590	$1,908
2	2023	50	$860	$1,784	$2,081	$2,775
3	2024	151	$2,620	$5,889	$7,550	$10,721
4	2025	233	$4,041	$9,549	$12,577	$17,701
5	2026	277	$4,803	$11,627	$15,503	$22,700
6	2027	295	$5,111	$12,962	$17,970	$25,040
7	2028	295	$5,121	$13,283	$18,300	$27,451
8	2029	288	$5,000	$13,544	$19,308	$28,817
9	2030	277	$4,805	$13,571	$18,556	$28,250
10	2031	264	$4,588	$13,487	$18,776	$27,768
11	2032	250	$4,336	$12,746	$17,745	$26,243
12	2033	236	$4,096	$12,041	$16,763	$24,791
13	2034	223	$3,863	$11,356	$15,809	$23,379
14	2035	210	$3,648	$10,724	$14,929	$22,079
15	2036	198	$3,428	$10,075	$14,026	$20,743
16	2037	186	$3,228	$9,489	$13,210	$19,536
17	2038	175	$3,041	$8,939	$12,444	$18,403
18	2039	166	$2,872	$8,441	$11,751	$17,379
19	2040	156	$2,701	$7,940	$11,054	$16,347
20	2041	147	$2,548	$7,490	$10,428	$15,421
21	2042	139	$2,405	$7,070	$9,843	$14,557
22	2043	131	$2,276	$6,691	$9,315	$13,776
23	2044	124	$2,147	$6,312	$8,787	$12,995
24	2045	117	$2,031	$5,970	$8,312	$12,292
25	2046	111	$1,923	$5,652	$7,868	$11,636
Total		**4,742**	**$82,282**	**$228,087**	**$314,496**	**$462,707**
Average			**$3,291**	**$9,123**	**$12,580**	**$18,508**

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 $314,000 total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at $110,000, noting that costs could be greater in some landscapes or if consultants were used.
- Carbon income was estimated to be $204,000 greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 2.9:1. Based on the revenue flows shown in Table 2, and assuming carbon was sold at the base rate, establishment costs would be recovered after 9 years.

- Besides carbon sequestration, other production benefits associated with shelterbelts could bring include reduced dryland salinity risk, reduced windspeeds across the production area, a nectar source for bees and greater biodiversity.

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

Item	Costs or Benefit
Establishment costs	$110,000
Carbon revenue, base case	$314,000
Potential profit	$204,000
Ratio of revenue to establishment costs	2.9:1
Time until costs recovered	9 years

7. Offsetting enterprise 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).
- The owners of the Loxton apple orchard are currently analysing their carbon footprint, with results not yet in, but based on international studies apple crops may produce approx. 200 kg of CO_2e/t of apples produced (Figueiredo et al. 2013); in the 130 ha Loxton orchard this could equate to approx. 1,200 tCO_2e.
- With the present project offering the opportunity to offset 190 tCO_2e each year for 25 years, the proposed shelterbelts would offset approx. 16 % of orchard emissions, which could allow access to low carbon markets in future.
- To achieve carbon neutrality, the theoretical planting described here would need to be increased to 300 ha of mixed environmental planting. It is possible land could be purchased away from the Loxton site for this purpose. Alternatively, carbon credits could be purchased from carbon projects registered with the Clean Energy Regulator.

8. Impact of planting layout

This case study differed from most others in this series in that plantings were set as environmental plantings rather than mallee plantings, as the orchard owners are interested in maximising biodiversity as well as carbon sequestration. To gain preliminary information on how this impacts carbon yield, test runs were conducted with FullCAM modelling mallee plantings on the Loxton planting area. Results suggested carbon yields would be around 27 % higher with mallee plantings (see Appendix 1 vs Fig. 1, see also Case Study 6 in this Series). This is presumably due to the higher tree density in mallee plantings compared to mixed species environmental plantings. Mallee plantings could be pursued further if the owners of the orchard wanted to maximise carbon yield.

9. Conclusions

- Carbon revenue from environmental plantings shelterbelts in the Loxton region are highly likely to exceed cost of establishment, and could return close to three times the set-up costs, with set-up costs recovered after 9 years.
- Co-benefits such as additional shelter for orchards, greater biodiversity, improved aesthetics and better access to markets may add extra value.
- The preliminary finding that carbon yields from mixed environmental plantings are around 27 % lower than from mallee plantings is of interest and deserves further study across more sites; despite the lower carbon yields, this planting type is still preferred by the owner of this orchard due to the greater biodiversity.
- 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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Appendix 1. FullCAM output, cumulative carbon yield at Loxton (tC/ha), with mallee species in a block.