Growing revenue using carbon shelterbelts,

Case Study 7, Karoonda

14 August 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.*

- *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 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 7 – Background

Case Study 7 is a 2500 ha mixed farm located near Karoonda, 150 km south-east of Adelaide. Average annual rainfall is approx. 330 mm and soils are mostly sandy dunes and swales. There is approx. 150 ha of remnant native vegetation on the property on hill tops and lighter soils.

This sheep enterprise is based on a self-replacing flock of 1,700 Merinos grazing annual pastures and cereals sown for sheep feed or hay. The cropping enterprise is based on 950 ha of mostly wheat and barley with some lupins, oats and rye also sown. Over the long term, cereal yields have averaged around 1.5-2 t/ha, though yields have been lower in recent years.

The manager of the property is interested in shelterbelt plantings for the following reasons:

- return more vegetation to the landscape
- provide habitat for wildlife
- provide extra shade and shelter for lambing ewes
- reduce windspeeds across farm
- help restore the water balance
- revegetate sand-hills that have previously blown out and need protection from stock and stabilising.

In addition, the manager is mindful of the fact there may in future be an opportunity to earn extra income from carbon sequestration in trees, or achieve premiums for meat and grain produced on the farm if he can show the farm to be a low net emissions property.

3. Shelterbelt design

A theoretical shelterbelt design for the Karoonda 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 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. The total area allocated to shelterbelts was 50 ha, representing 2.0 % of the farm area.

Fig. 1. Shelterbelt design on the 2,150 ha property near Karoonda.

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 50 ha ($50,000). At these rates, the total cost of fencing and seeding would be $175,000. Direct seeding would need to be done in a reasonable rainfall year to have a good chance of success. 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
25 km fencing	$5000/km	$125,000
50 ha seeding	$1000/ha	$50,000
Post-seeding weed control, fence repairs		$10,000
Total		**$185,000**

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 $185,000. 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 3 to 10 when trees grow fastest (approx. 15-27 tCO_2e/ha/yr), dropping to 5-15 tCO_2e/ha/yr in later years.

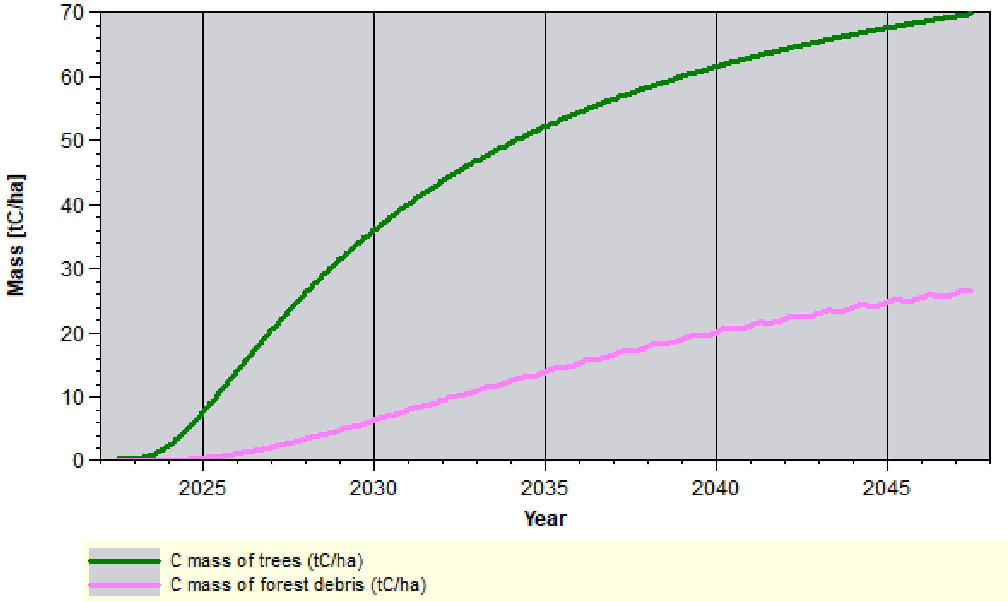

Fig. 2. FullCAM output from one site at Karoonda showing cumulative carbon yield (tC/ha) over 25 years with mallee eucalyptus species planted in a belt at <1,500 stems/ha.

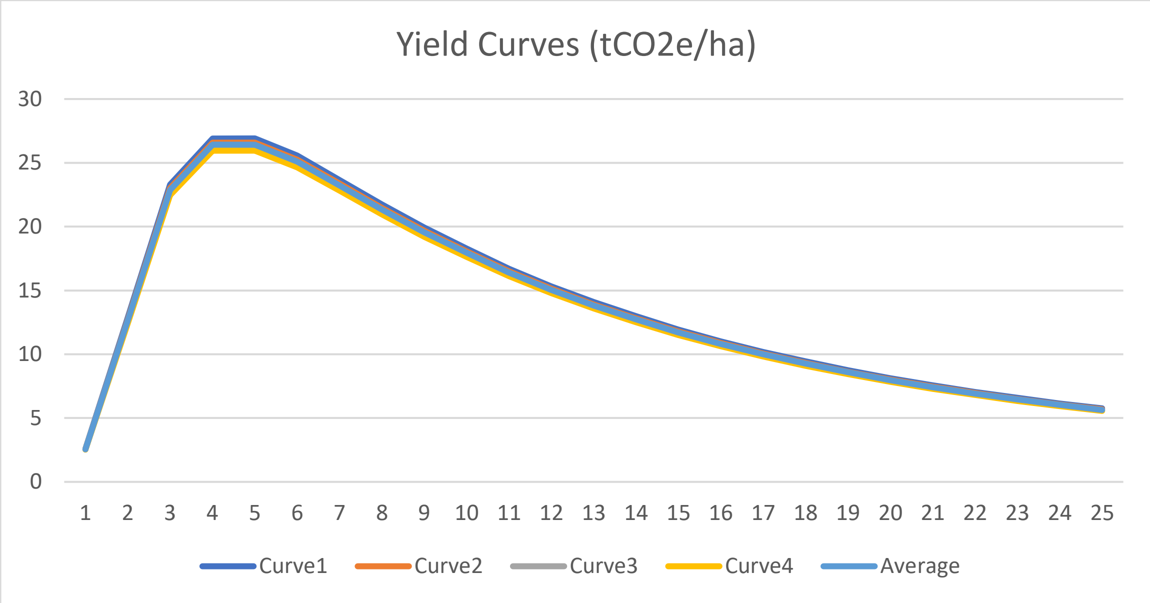

Fig. 3. Yield curves (tCO_2e/ha) at 4 different locations at Karoonda over the 25 years of the project.

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 13,008 tCO_2e (Fig. 4), equating to 520 tCO_2e/yr (Fig. 5), or 10.4 tCO_2e/ha/yr.

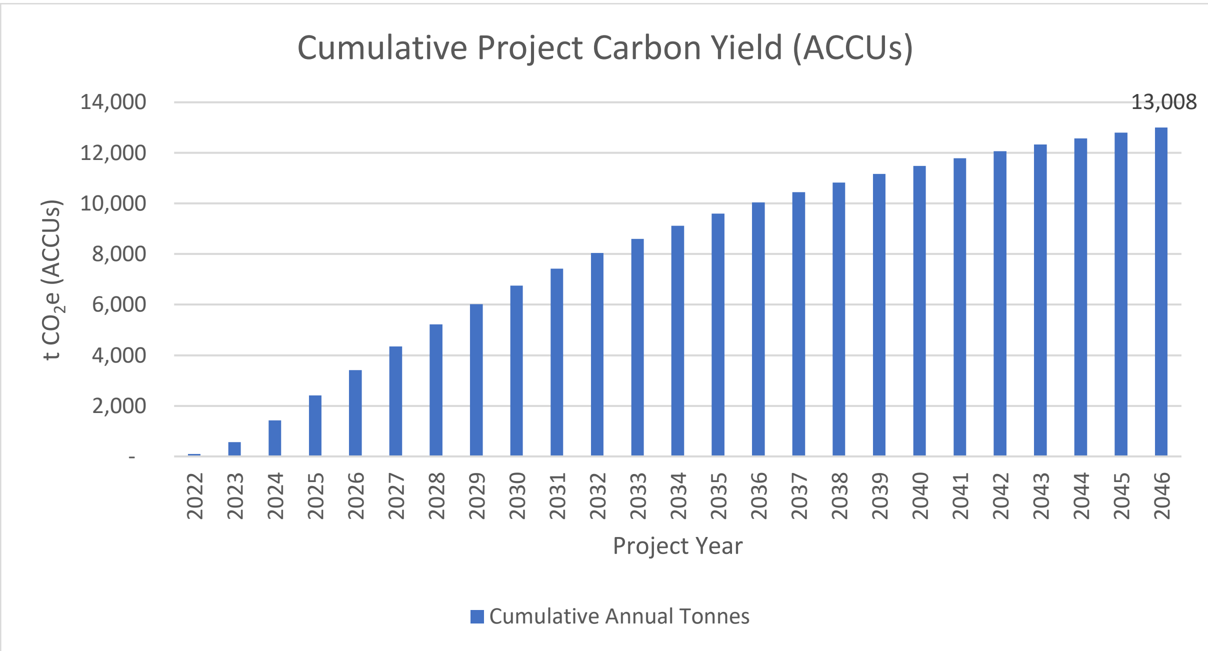

Fig. 4. Cumulative carbon yield from the 50 ha carbon estimation area at Karoonda over 25 years.

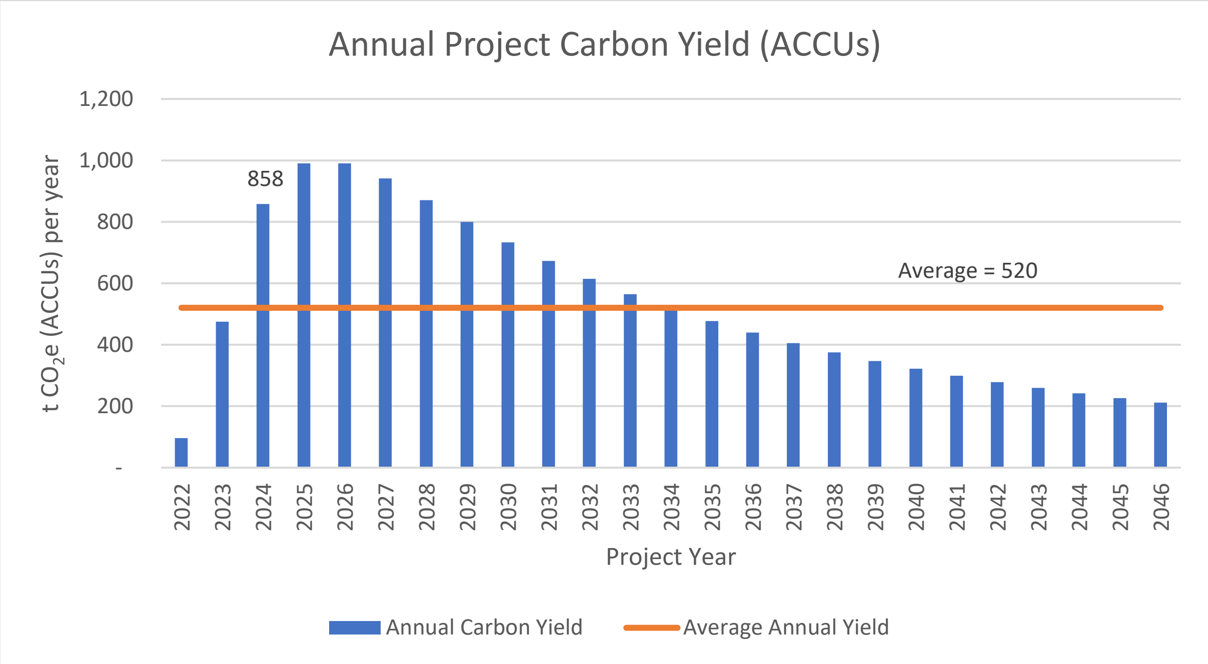

Fig. 5. Annual carbon yields (tCO_2e/yr) calculated from 4 different locations near Karoonda over 25 years, and average annual yield across all years.

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 $46.81/t; the base price was $35/t increasing to $71/t averaging $64.06/t; and the high scenario was $42 increasing to $105 averaging $93.82/t.

Revenues under the flat, low, base and high pricing scenarios totalled $226,000, $609,000, $833,000 and $1.22m, respectively, and annual incomes of $9,000, $24,000, $33,000 and $49,000. Because annual carbon yields were at their highest in years 3 to 10, revenue was also greatest in those years ($14,000-$81,000/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 $46.81)	$35 to $71 (avg $64.06)	$42 to $105 (avg $93.82)
1	2022	96	$1,660	$3,063	$3,350	$4,020
2	2023	475	$8,234	$17,085	$19,933	$26,577
3	2024	858	$14,881	$33,449	$42,884	$60,895
4	2025	991	$17,188	$40,618	$53,496	$75,291
5	2026	991	$17,190	$41,613	$55,483	$81,243
6	2027	941	$16,331	$41,415	$57,416	$80,006
7	2028	871	$15,104	$39,175	$53,974	$80,962
8	2029	800	$13,884	$37,611	$53,615	$80,022
9	2030	733	$12,721	$35,928	$49,126	$74,788
10	2031	673	$11,672	$34,311	$47,766	$70,640
11	2032	615	$10,669	$31,362	$43,661	$64,569
12	2033	564	$9,786	$28,767	$40,048	$59,227
13	2034	518	$8,990	$26,425	$36,788	$54,404
14	2035	477	$8,284	$24,351	$33,900	$50,134
15	2036	439	$7,620	$22,398	$31,181	$46,113
16	2037	405	$7,033	$20,674	$28,782	$42,565
17	2038	375	$6,503	$19,115	$26,611	$39,355
18	2039	347	$6,029	$17,721	$24,670	$36,484
19	2040	322	$5,585	$16,417	$22,855	$33,799
20	2041	299	$5,189	$15,253	$21,234	$31,402
21	2042	278	$4,828	$14,193	$19,759	$29,221
22	2043	259	$4,502	$13,232	$18,421	$27,243
23	2044	242	$4,199	$12,344	$17,185	$25,414
24	2045	226	$3,925	$11,539	$16,064	$23,756
25	2046	212	$3,675	$10,802	$15,038	$22,239
Total		**13,008**	**$225,683**	**$608,858**	**$833,240**	**$1,220,369**
Average			**$9,027**	**$24,354**	**$33,330**	**$48,815**

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 $833,000 total carbon revenue.
- For the purposes of this case study, establishment costs were estimated at $185,000, noting that costs could be greater in some landscapes or if consultants were used.
- Carbon income was estimated to be $648,000 greater than cost of establishing and maintaining the shelterbelts. The ratio of revenue to establishment costs was 4.5:1. 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 Karoonda 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 $10,000 per year (68 lambs @ $150), or $250,000 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	$185,000
Carbon revenue, base case	$833,000
Potential profit	$648,000
Ratio of revenue to establishment costs	4.5:1
Time until costs recovered	6 years
Possible value of extra lambs if lambing survival lifts 4 %	$250,000

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 and 0.25 tCO_2e/t pulses (Western Australian Department of Agriculture and Food 2022). On this farm, cropping may generate approx. 400 t tCO_2e. 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 1,700 ewes, the sheep likely produce another 800 tCO_2e/yr.
- With the present project offers the opportunity to offset 520 tCO_2e per year for 25 years, the proposed shelterbelts would offset 43 % of farm emissions, potentially giving 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 $9/kg instead of $8/kg, this would generate an extra $20,000/yr from 1000 sales lambs with 20 kg carcase weight).

- To achieve carbon neutrality, the case study 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 manager finds it encouraging that the proposed shelterbelt design offers a way of offsetting around 43 % of farm emissions without major negative impacts on production.
- The manager is 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 50 ha of shelterbelts in one year, and a logistical challenge given lack of experience getting trees established and variable rainfall.
- 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.
- The manager is aware that establishing shelterbelts through direct seeding can be difficult, and could fail in a dry year, particularly in the unstable sands he wants to target first.
- Finally, the manager would also be open to using a mixture of block plantings and shelterbelt plantings to minimise fencing and allow trees to be located on least productive paddocks (e.g. sandhills). 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).

9. Conclusions

- Using the base case pricing forecast, carbon revenue from shelterbelts was established to be 4.5 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.

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

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>.