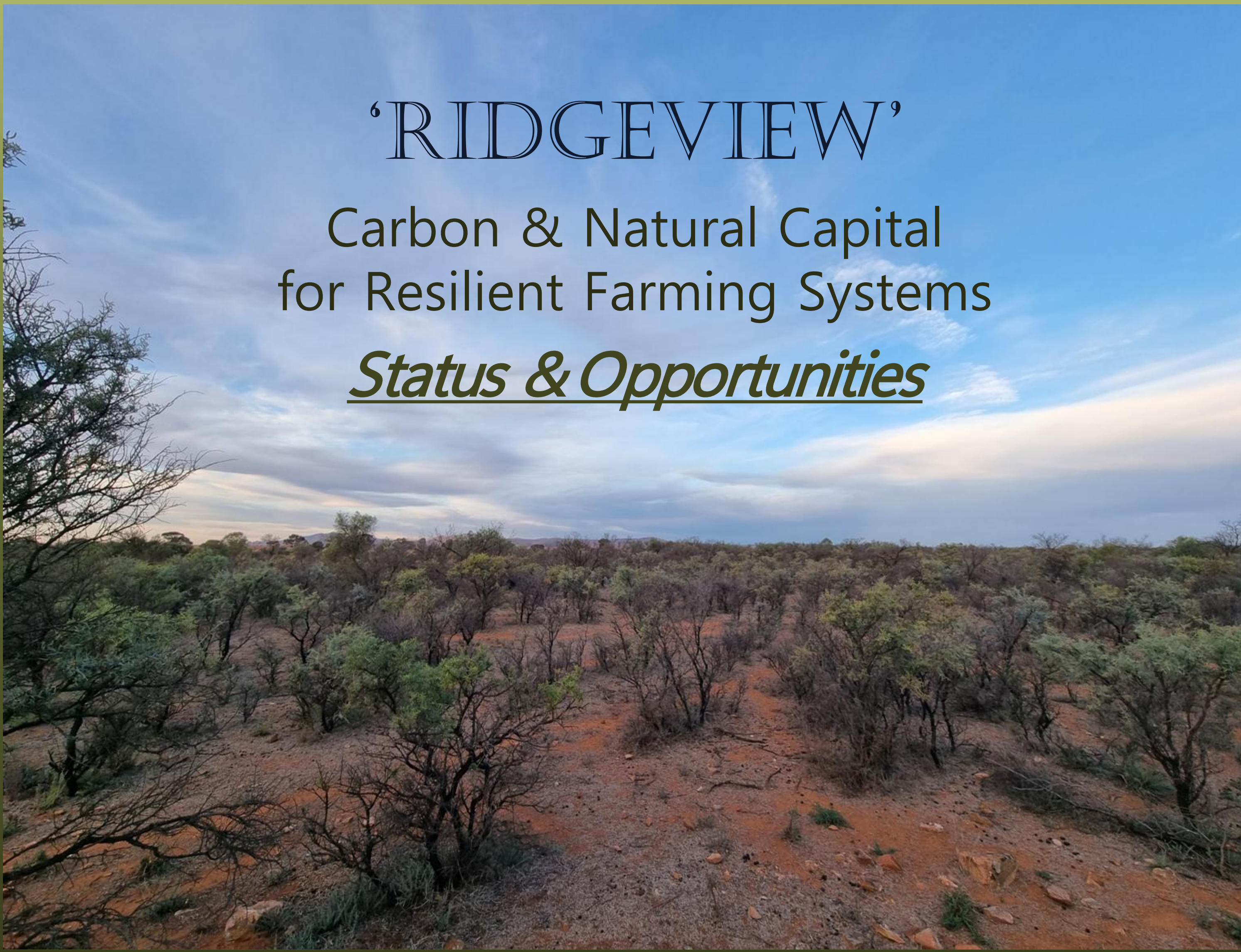

Prepared by Daniel Hanisch (Project Manager/Ecologist – RegenCo)

for Tim & Christy Luckraft (Trading under "T K Luckraft"),

Primary Industries & Regions SA (PIRSA), and

Upper North Farming Systems (UNFS)

March 2025

COMMERCIAL-IN-CONFIDENCE

WHAT ARE WE DOING TODAY

Australian Farmers have been working the land for centuries, each generation motivated to leave the land more resilient, productive, and profitable than how they found it. It's this spirit of being stewards of the land that inspires Regenco's mission; we exist to help farmers sustain the land that sustains Australia. This generation, and every generation to come.

We value and respect this expertise that comes from years of working the land. So, we built a natural capital business that complements farmers existing land management practices. As a group of pastoralists, grazing land management specialists and scientists with over 100 years combined experience working with the land, we have first-hand experience of the unique challenges farmers face. We listen to what farmers want and work in partnership to create mutually beneficial land management plans that help them make the most of their land. One that maximises their profits and productivity, while regenerating the land. It's an investment in our farmers, and our future.

A future that's good for producers, paddocks and the planet.

Regenco, value that grows.

'RIDGEVIEW'

Carbon & Natural Capital for Resilient Farming Systems

Status & Opportunities

Dear Tim & Christy, Primary Industries & Regions SA (PIRSA), and Upper North Farming Systems,

We are grateful firstly for the opportunity to be involved, and secondly for your contribution of time and resources to help us develop this report.

The broader PIRSA program that funded this project was an important investigation into identifying where environmental market opportunities aligned with improving productivity, profitability and resilience to a changing climate. Based on our findings in this report, we believe there are clear opportunities for the Luckrafts' enterprise to deliver subtle management changes that can drive both economic and environmental improvement, while continuing to maintain agricultural production into the future.

This important case study highlights ways in which other landholders in the region could consider the value of natural capital and environmental markets being integrated into their current enterprise mix. While each enterprise and its landholdings is unique, there are some valuable take-away messages in this report for other regional businesses, which are highlighted in the executive summary, climate resilience being key.

We have to expect that the future is not going to be a simple repetition of the past- either for markets or the environment. Taking on board the findings of this report will stand the Luckrafts (and other landholders in the region, and indeed across the State) in a much stronger position to capitalise on opportunities that emerge, while keeping a key focus on agricultural production and the financial drivers of their business.

We wish you well in the implementation of the aspects of this report that you see having significant positive impacts for your business, and standby to provide any further assistance you require moving forward.

Dr Tim Moore
Head of Science and Strategy, RegenCo
Greg Noonan
CEO and Managing Director, RegenCo

‘RIDGEVIEW’

Carbon & Natural Capital for Resilient Farming Systems

Status & Opportunities

Contents





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1. LANDSCAPE & CLIMATE CONTEXT

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LANDSCAPE CONTEXT – REGIONAL SETTING

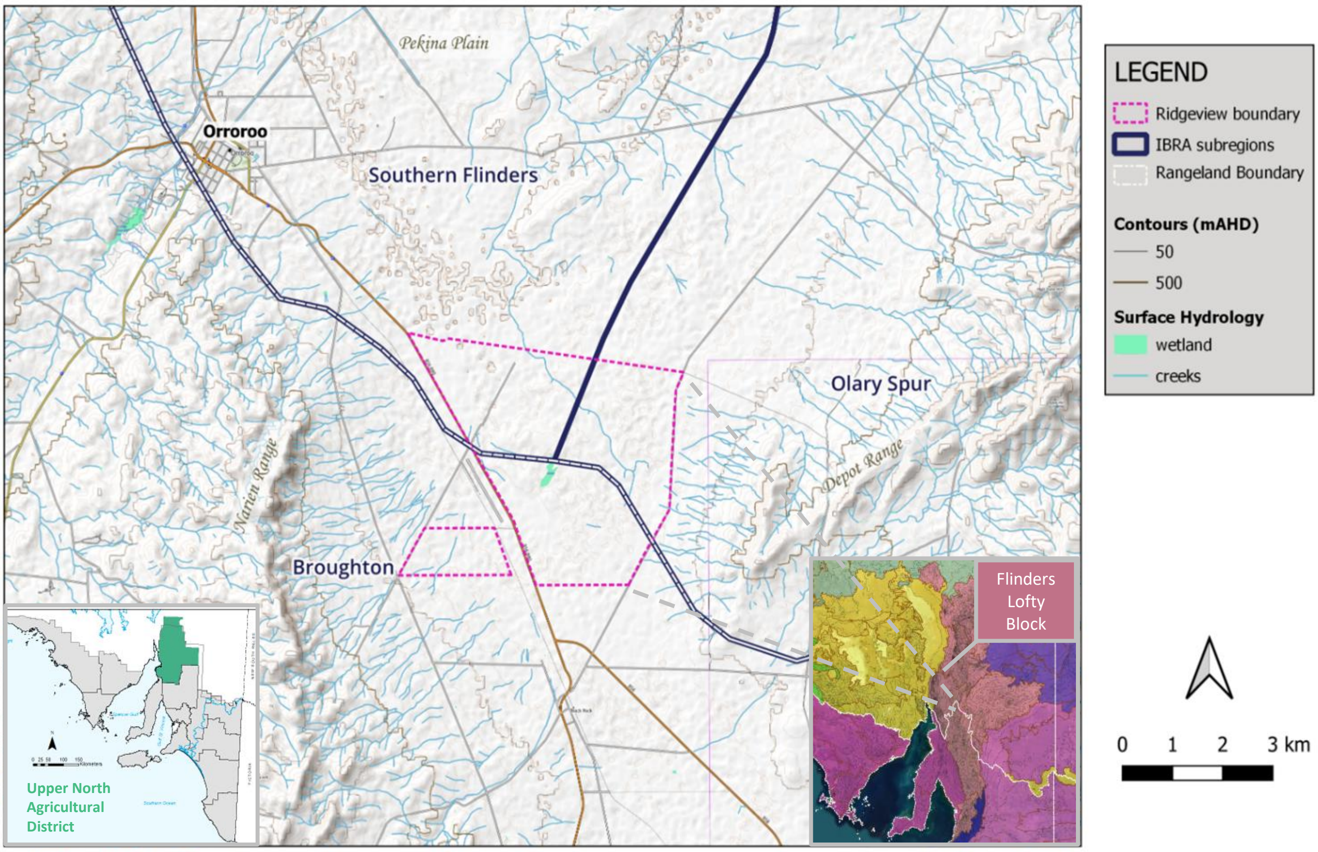
Ridgeview is a 1800 ha sheep and grain mixed farming property located in the “Upper North” agricultural district of South Australia, about 5 km south-east of Orroroo.

The property lies in the middle of the Flinders Lofty Block bioregion, which stretches from Maree in the North to Myponga in the South and consists of six subregions. The junction of three of these subregions - Southern Flinders, Olary Spur and Broughton - is located in the middle of Ridgeview.

The Broughton subregion is part of the Mt Lofty woodlands ecoregion (Mediterranean forests and woodlands biome), while Southern Flinders and Olary Spur are part of the Tirari-Sturt stony desert ecoregion (Deserts and xeric shrublands biome).

The Broughton boundary is also regarded as the boundary of the Australian Rangelands, roughly following the Goyder Line which demarcates the reliable rainfall region for cropping in South Australia.

As such, Ridgeview can be regarded as occurring in ecologically transitional country - where diversity of plants, birds and other biota is often maximised - as well as agriculturally transitional country - where cropping ceases to be viable and low intensity grazing of native shrublands becomes preferred practice.



Regional context map for Ridgeview mixed farming property

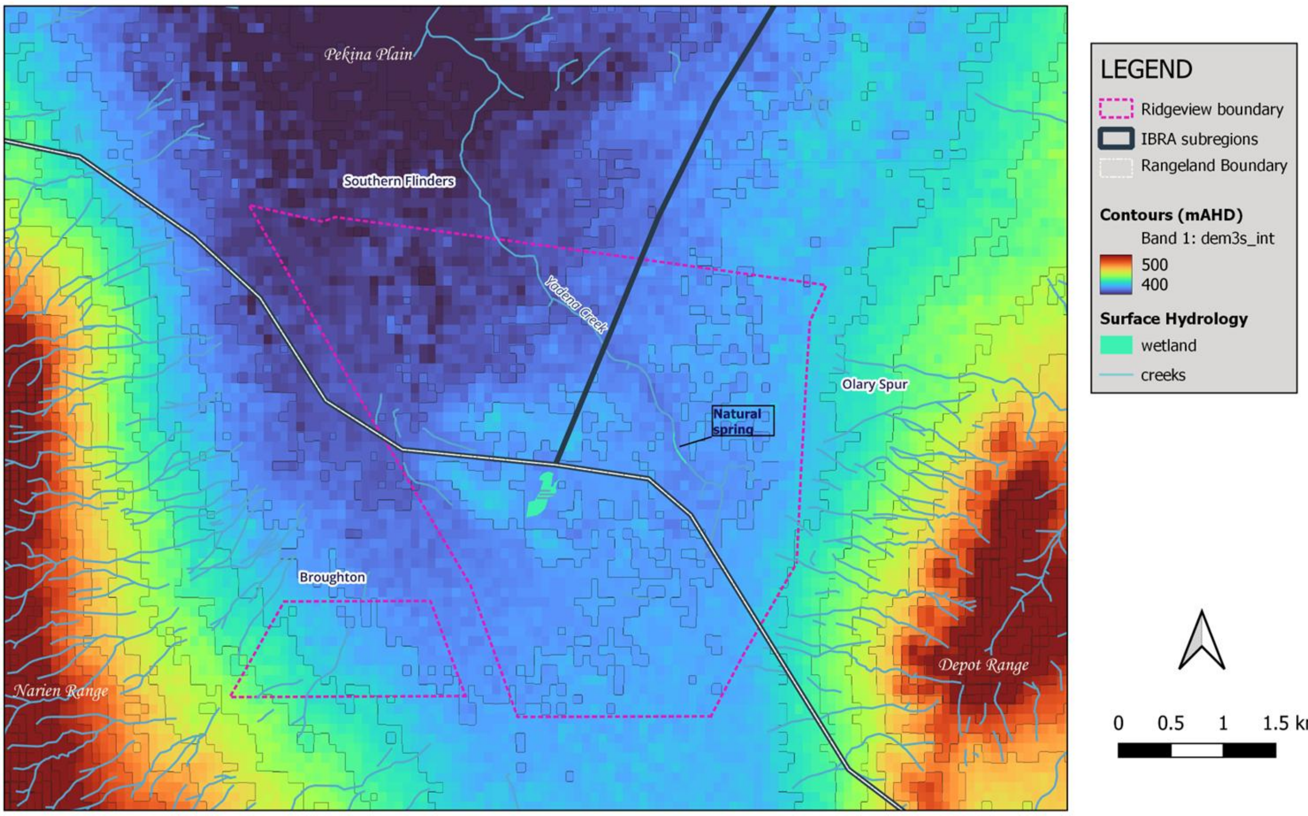
LANDSCAPE CONTEXT – TOPOGRAPHY & HYDROLOGY

Ridgeview lies at an altitude of 400-450 mAHD on the largely cleared and modified Black Rock plain between two branches of the Southern Flinders Ranges - Narien Range to the west, within the Broughton subregion, and Depot Range to the east, within the Olary Spur subregion. To the north, in the Southern Flinders subregion, lies the Pekina Plain. The topography of the property generally slopes from south to north and from east to west, with a low rise in the centre.

Although only receiving about 250-350 ml of rainfall annually, Ridgeview has some noteworthy hydrological features owing to its receiving position in the landscape (i.e. outflow plains and foothills).

Yadena Creek is a locally significant watercourse whose headwaters occur on Ridgeview. This creek is ephemeral and rarely flows but has a semi-permanent spring, which is fed by infiltration of rain on the adjacent ranges to local groundwater systems. The creek passes through regenerating acacia-myoporum shrubland in the north of the property to the Pekina Plain.

There is also a natural wetland area, known as the Lagoon, near the junction of the bioregions in the middle of Ridgeview, which is seasonally inundated in good rain periods. This locally rare landscape feature would have historically supported a productive and diverse vegetation community, as well as a suite of waterbirds and other fauna when it was inundated. However, it has been subject to heavy grazing and cropping historically and is currently used for grazing.



Ridgeview elevation and hydrological features

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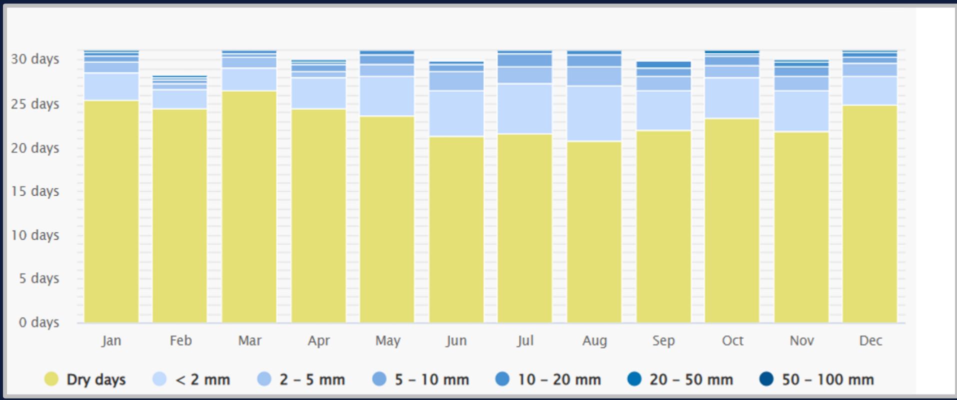
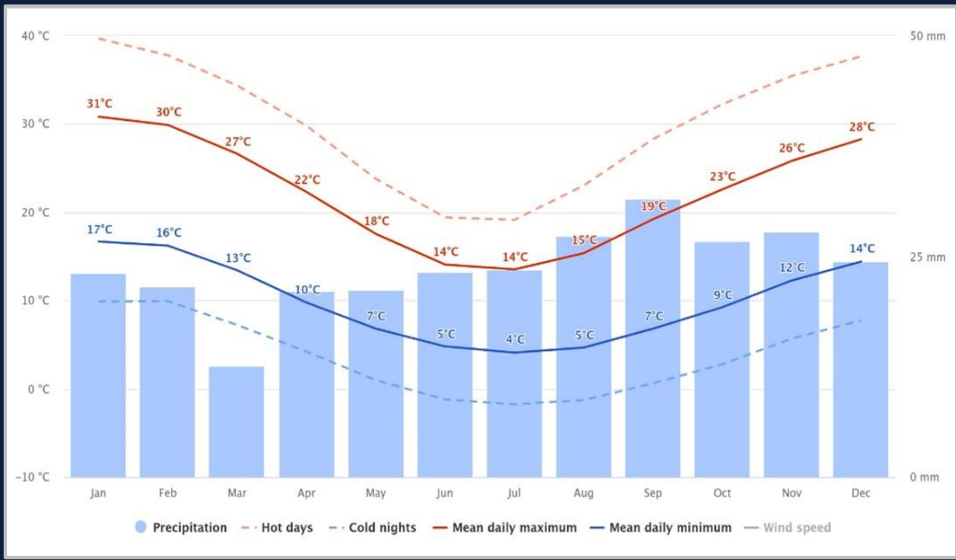
CLIMATE CONTEXT – TEMPERATURE & WATER BALANCE

The climate experienced by Ridgeview, and the region in general, is classified as semi-arid, generally receiving rainfall of 250-350 mm per year. The nearby ranges receive slightly more rainfall on their peaks, at about 350-450 mm per year.



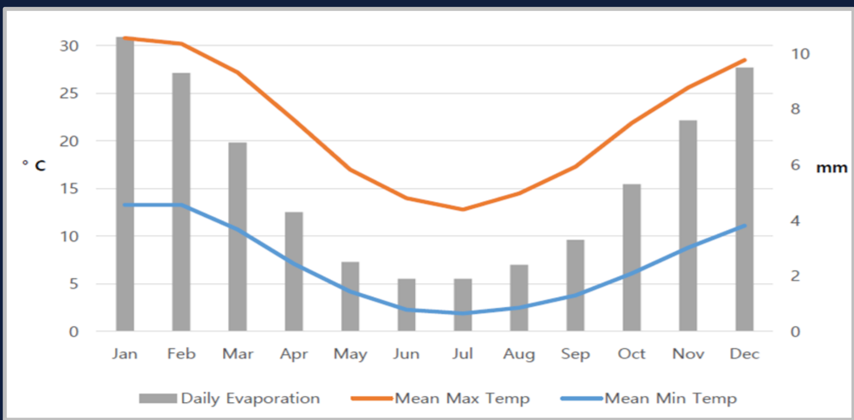
The precipitation diagram for Orroroo shows on how many days per month certain precipitation amounts are reached. Note that rainfall days are lowest in late summer-early autumn, with the larger precipitation events generally occurring late winter-spring. (Source: Meteoblue website)

The long-term rainfall pattern favours winter-spring rainfall, however this has shifted towards a heavier summer rainfall pattern and reduced winter rainfall in the past two decades, such that rainfall is now more even throughout the year. Average maximum summer season temperatures are high (high 20s to low 30s) and maximum winter temperatures are mild (low to mid teens), while overnight winter minimums are generally below 5C and sometimes fall below zero.



The “mean daily maximum” (solid red line) shows the maximum temperature of an average day for every month for Orroroo. “Mean daily minimum” (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month for the last 30 years. Note the very high hot day average from November to February (over 35C) and the very low cold night minimum from June to August (below 0C). (Source: Meteoblue website)

Total annual pan evaporation is 1971 mm, peaking at 30 mm per day in January.



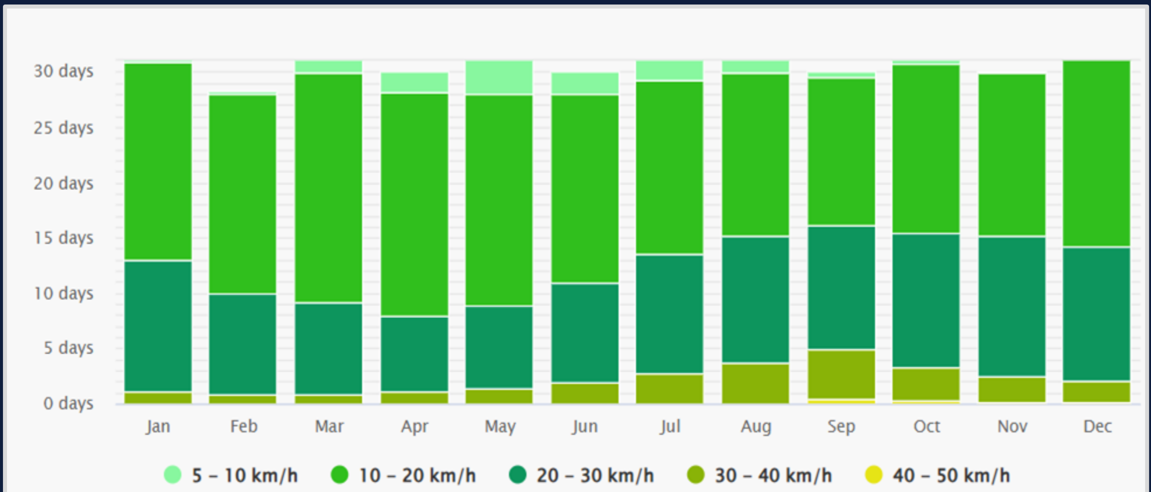
The pan evaporation diagram shows the average daily evaporation for each month. Note the very high evaporation rates from Nov. to March, many times higher than average rainfall. (Source: BOM website: Yongala weather station)

CLIMATE CONTEXT – WIND SPEED, DIRECTION & SEASON

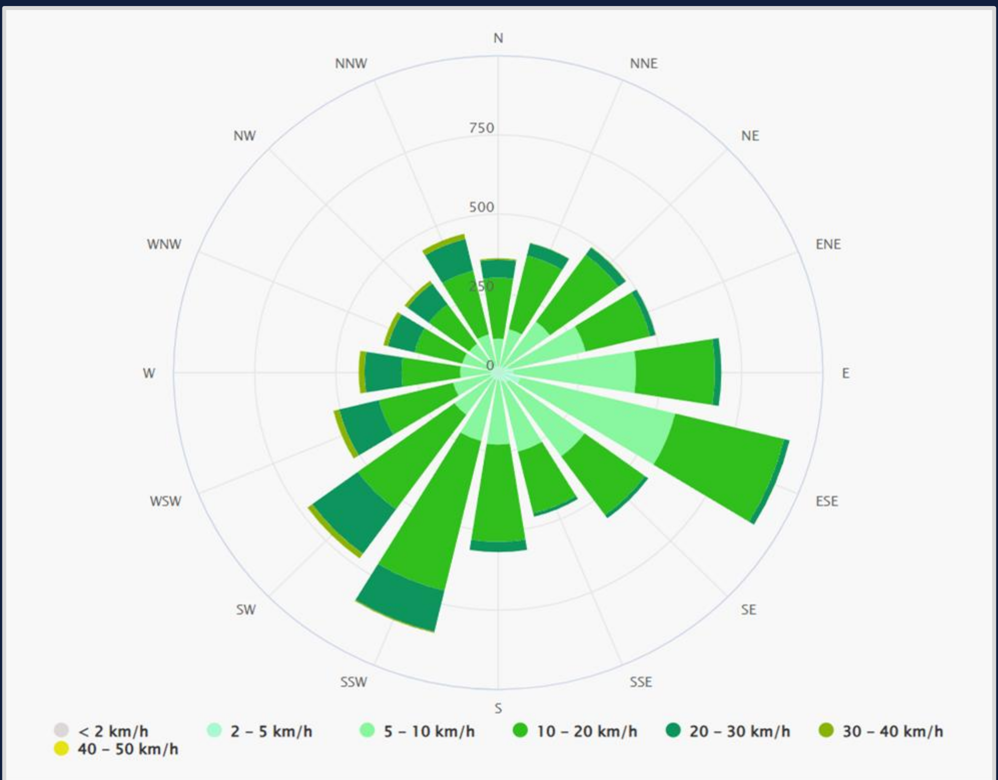
The Upper North Agricultural District of South Australia is a windy part of the state, and Orroroo is no exception, with the period from July to December being a period of particularly strong winds, before easing in late summer.

September is when wind speeds generally peak, while Autumn is the time of year with most gentle winds.

Wind direction is primarily from the south-west, especially when winds are strong (more than 20 km/h). Although a large proportion of annual winds also blow from the south-east, these tend to be more gentle breezes. Strong hot winds (up to 40 km/h) will sometimes blow from the north-west, especially from October-January.



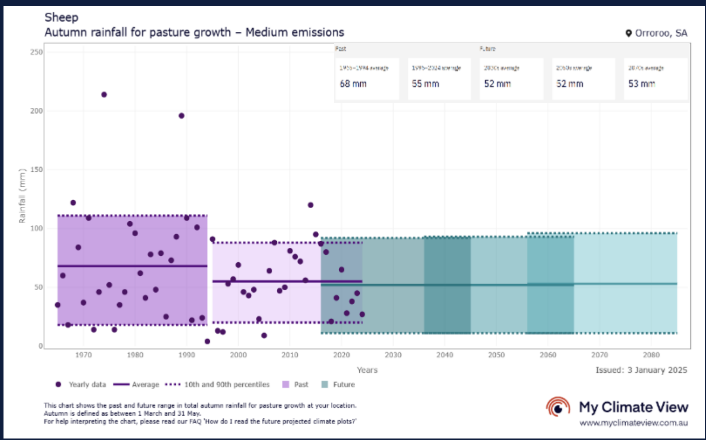
Wind Speed: The diagram shows the days per month during which the wind reaches a certain speed at Orroroo. Note that the windiest time of the year coincides with the wettest time of the year (Aug-Oct) and overlaps with the coldest time of year (Jun-Aug). (Source: Meteoblue website)

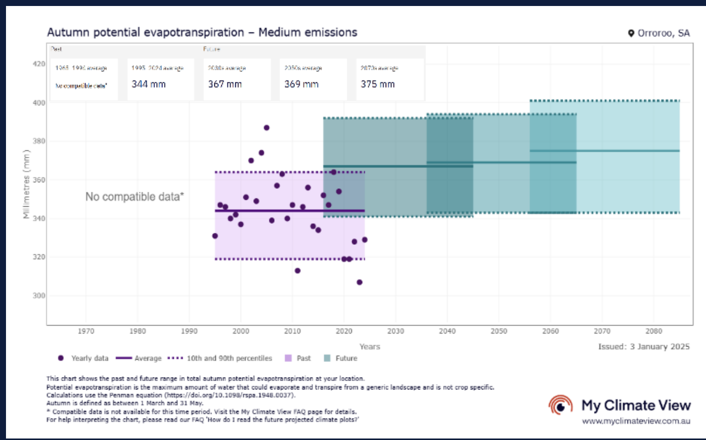


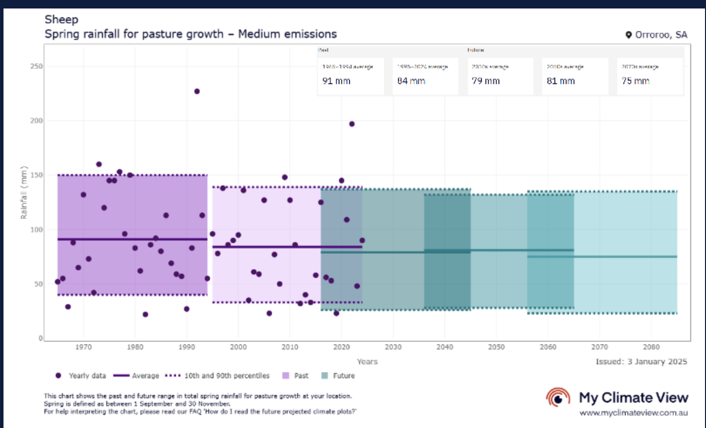
Wind Direction: The wind rose for Orroroo shows how many hours per year the wind blows from the indicated direction and at what speed. Note that almost all winds greater than 20 km/h, and all winds greater than 30 km/h, blow from a westerly direction (SW to NW) (Source: Meteoblue website)

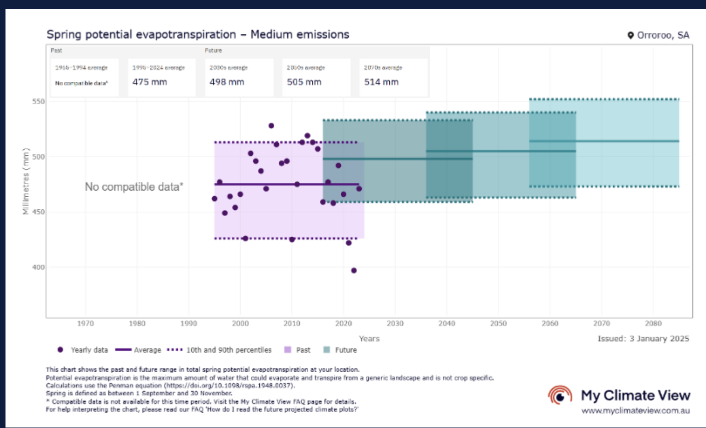
CLIMATE CONTEXT – WATER BALANCE TRENDS

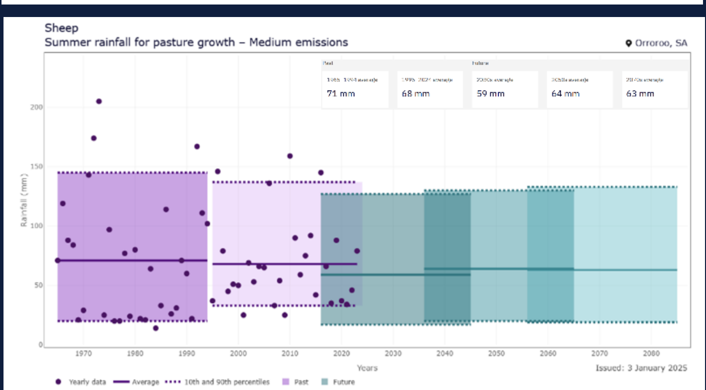
The graphs below, taken from [My Climate View](#) for the Orroroo region, provide seasonal trends for rainfall comparing the 1965-94 period to the 1995-2024 period. They also provide projections for both rainfall and evapotranspiration to 2030, 2050 and 2070 based on medium emission climate change model scenarios. All rainfall projections are for a decreasing trend, while all projections for evaporation are for an increasing trend, suggesting a worsening water deficit. Particularly noteworthy are the large increases in evapotranspiration in Autumn, Spring and Summer projected in the next five years under the influence of climate change.

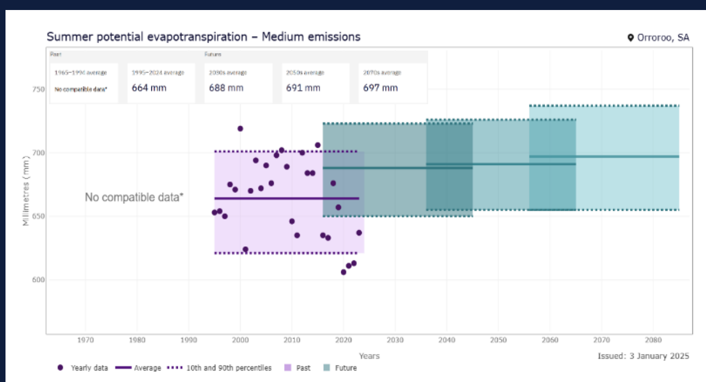












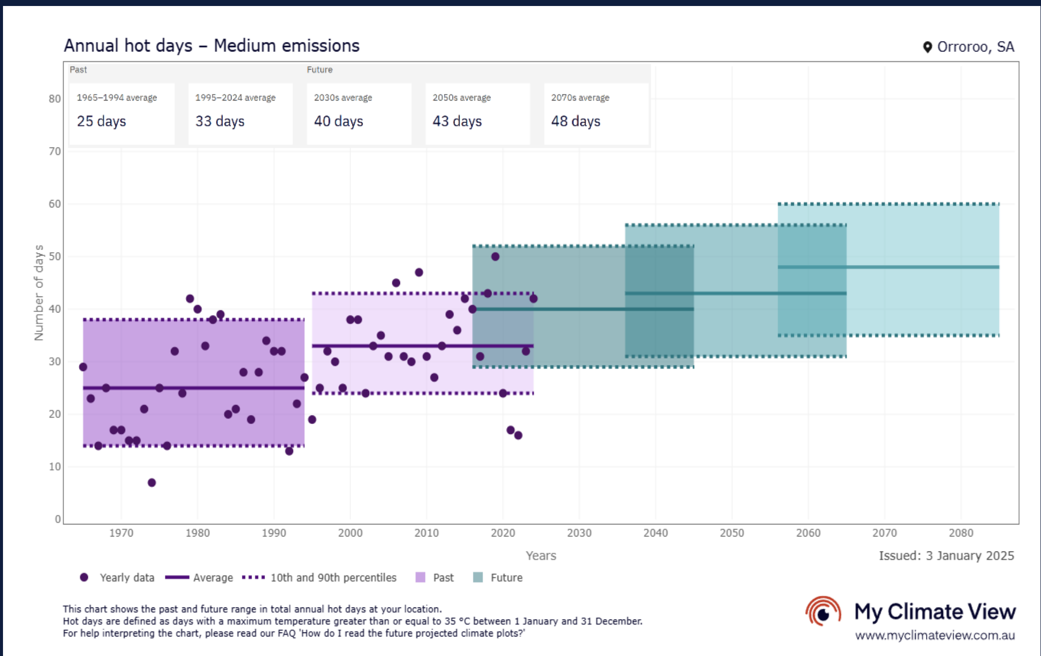
CLIMATE CONTEXT –HEAT STRESS RISK

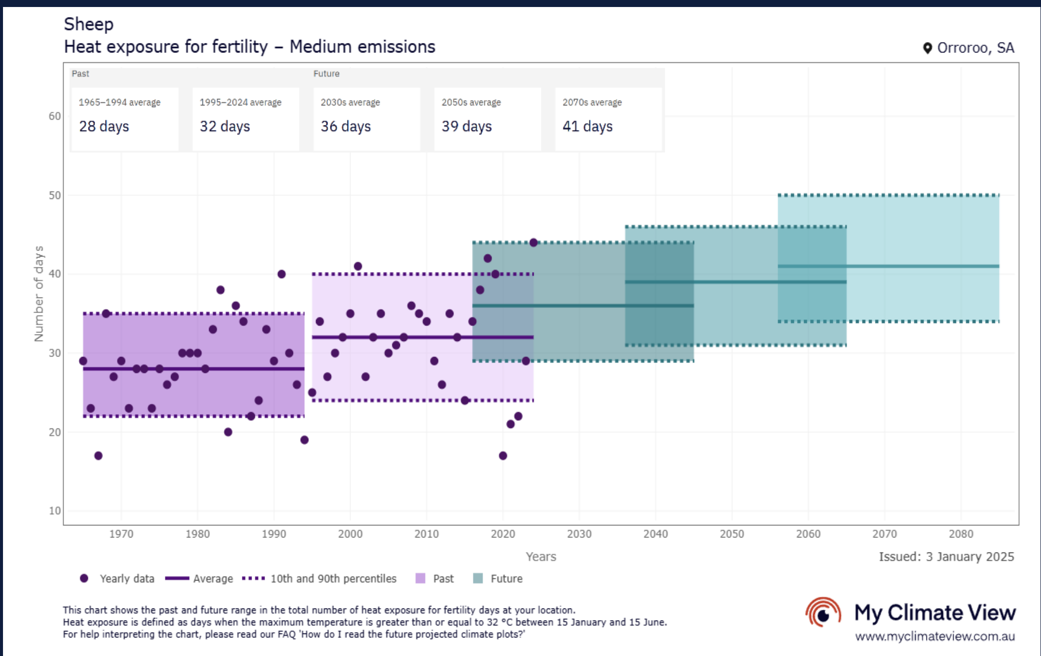
For well-fed, adult animals, the effects of higher temperatures are substantial. For example, sheep with a full fleece will often increase their respiration rate when the temperature reaches 18–21°C.

The graphs for the Orroroo region below are taken from My Climate View.

The first graph indicates the number of annual hot days (more than 35C) during the 1965-1994 and 1995-2024 periods, showing that the average number of hot days has increased from 25 to 33. The graph also provides projections for annual hot days to 2030, 2050 and 2070 based on medium emission climate change scenarios. All projections suggest that annual hot days will continue to increase up to an average 48 days per year by 2070 – almost twice the 1965-1994 figure.

The second graph shows the number of days per year that are potentially harmful to sheep fertility due to excessive heat. The data are restricted to 15 January - 15 June each year, which is the period identified as the main lambing time around Orroroo. Unsurprisingly, the current and projected trends follow much the same increasing pattern as those presented in the "Annual hot days" graph.





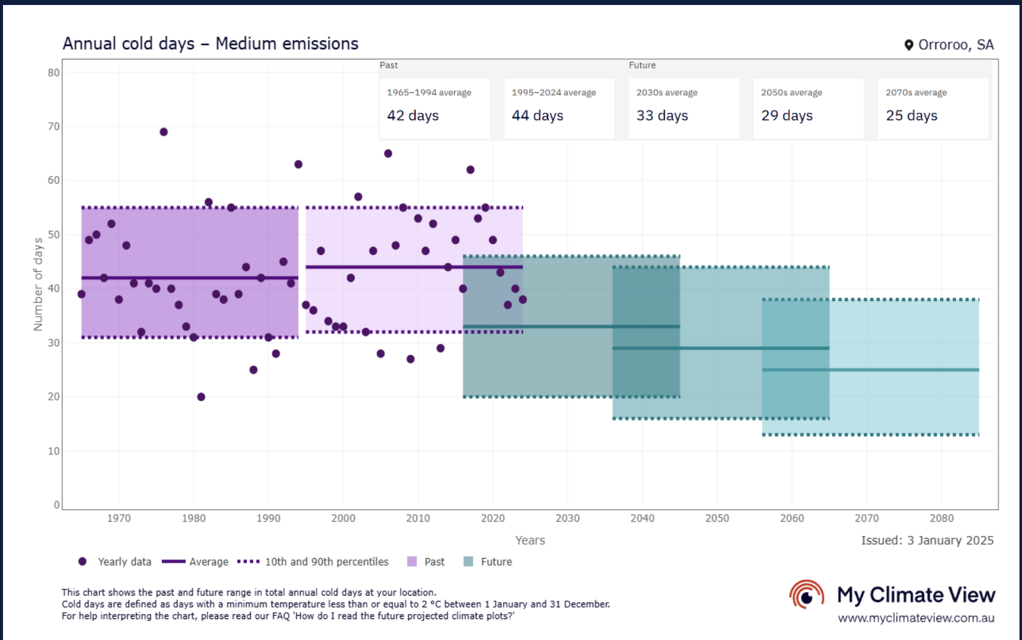
CLIMATE CONTEXT – COLD EXPOSURE RISK

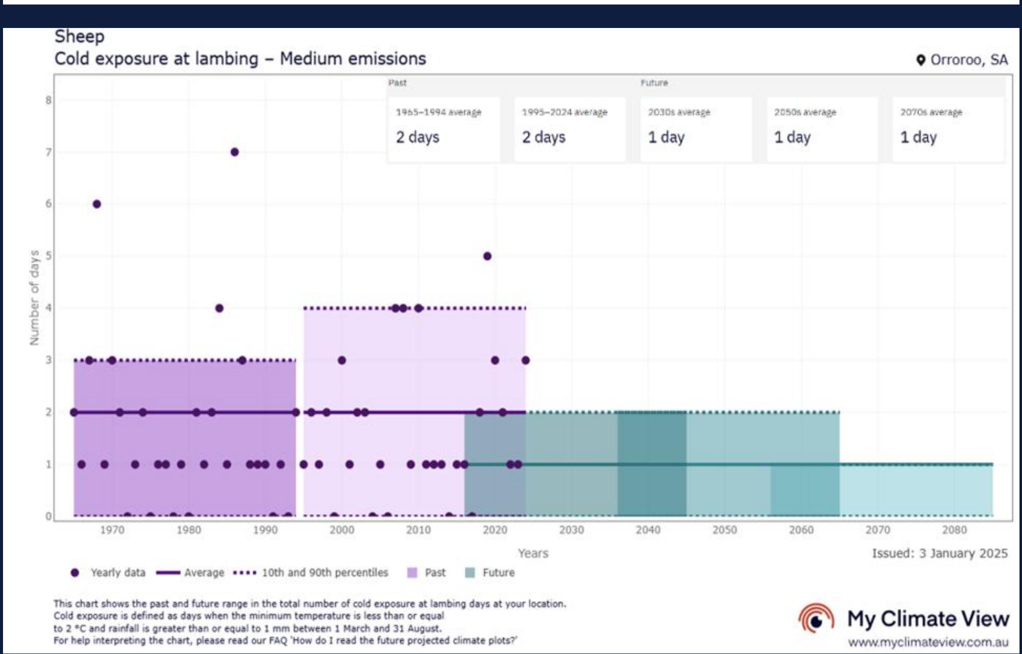
The graphs below are taken from My Climate View for the Orroroo region.

The first graph indicates the number of annual cold days (with minimum less than 2C) during the 1965-1994 and 1995-2024 periods, showing that the average number of cold days has increased from 42 to 44. The graph also provides projections for annual cold days to 2030, 2050 and 2070 based on medium emission climate change scenarios. All projections suggest that annual cold days will decrease to an average 25 days per year by 2070.

The second graph shows the number of days per year that are potentially harmful to lamb survival due to cold exposure (minimum less than 2C and at least 1 mm of rain). The data are restricted to 1 March – 31 August each year, which is the period identified as the time when lambs are young and vulnerable in the Upper North district. The data suggest a small drop in cold exposure days from a current average of 2 to 1 day by the 2030s.

Wind chill is also a major risk. For example, a 10 km/hr wind at sheep height can lower the effective temperature from 10 to -3°C. The lack of a wind chill factor in this analysis likely causes an underestimate of the true risk of cold exposure, especially as July & August are two of the coldest, wettest and windiest months near Orroroo.

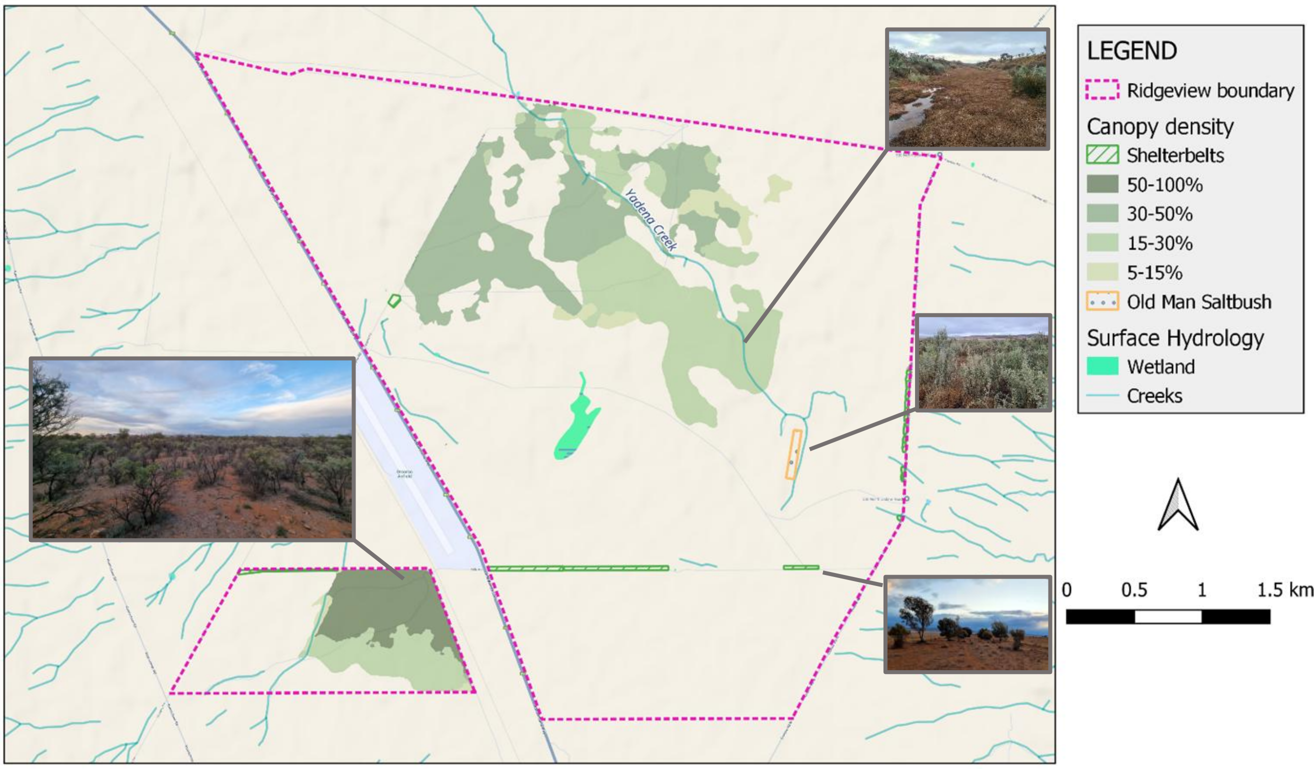




2. NATURAL CAPITAL ASSESSMENT

WOODY BIOMASS CARBON ASSESSMENT

- Embedded carbon and sequestration rates on Ridgeview in woody vegetation biomass were assessed and estimated using the Australian Government's official carbon model – FullCAM.
- The small block in the south-west of the property (near the Orroroo airstrip) contains a large area (about 60 ha) of regenerating *Acacia victoriae* tall shrubland. This area was formerly cleared and regrowth is recent enough to contribute to carbon footprint calculations as an annual sequestration contribution of about **200 tCO_2e-/yr**. The embedded carbon in this area is estimated to be **3,890 tCO_2e-**.
- A larger (about 250 ha) and older (about 40 years old) area of regenerating *Acacia victoriae +/- Myorporum platycarpum* mixed tall shrubland is found in the Scrub Paddock in the north of the property with the Yadena Creek passing through. The embedded carbon in this area is estimated to be **16,515 tCO_2e-**.
- Total combined woody biomass in these two larger areas of tall native shrubland is estimated at **20,405 tCO_2e-**.
- In addition, there are a few minor fenceline shelterbelts adding a small amount to the total woody biomass on the property. However, most fencelines on Ridgeview lack shelterbelts.
- There is also a 2 ha block of Old Man Saltbush that has been planted at the upstream end of Yadena Creek. Based on the literature (e.g Walden *et al*, 2017), this area is estimated to sequester about 2 tCO_2e-/yr.



Existing areas of native woody vegetation on Ridgeview

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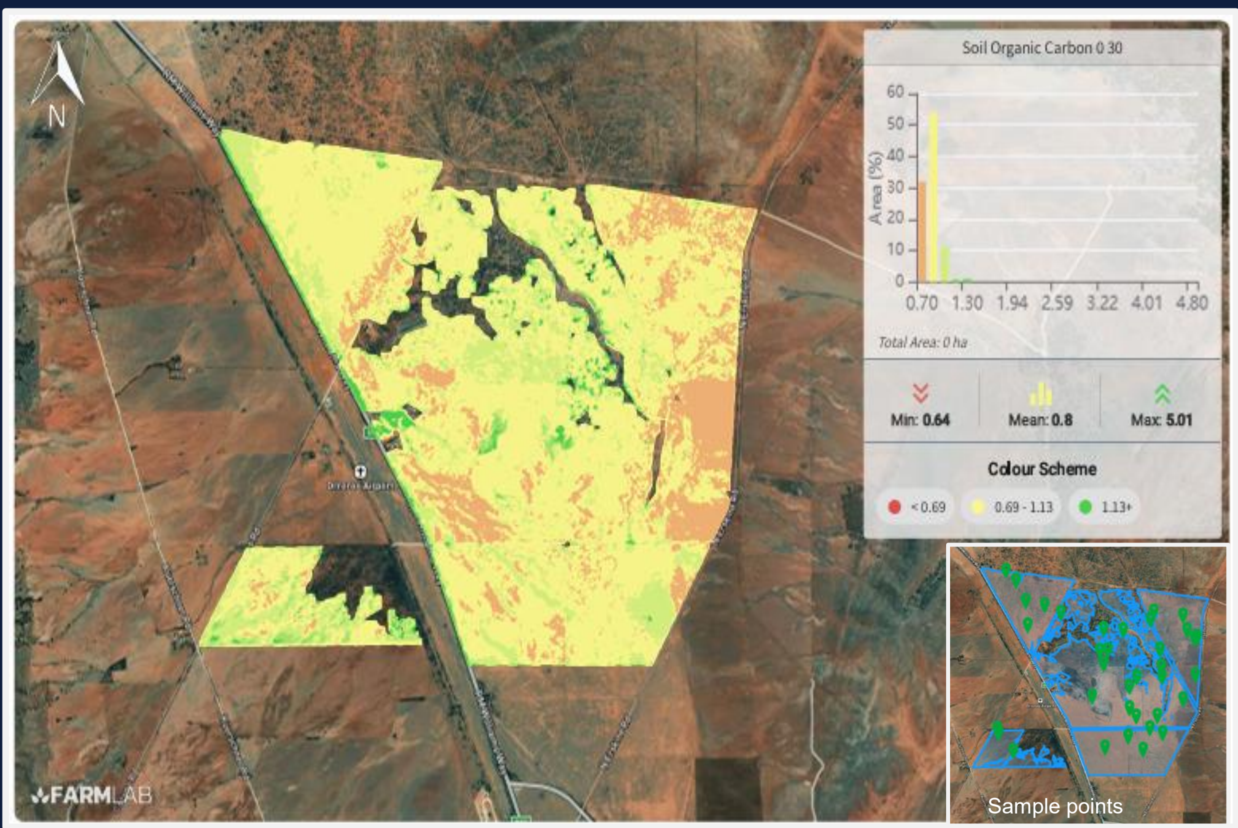
SOIL CARBON ASSESSMENT

- The soils on Ridgeview are mostly a heavy clay loam texture. In the Upper North District, there is an increasing trend in surface SOC content from sand to clay loam textures, with pasture soils having higher SOC concentration than crops (Schapel et al, 2024).

Table 2: Soil organic carbon benchmarks based on soil test data for the Upper North agricultural district

			SOC Benchmarks				
Texture	**Count**	**Mean %**	**25%**	**40%**	**50%**	**60%**	**75%**
Sand							
Loamy sand	29	0.62	0.49	0.51	0.53	0.54	0.64
Sandy loam	135	1.12	0.76	0.93	1.03	1.13	1.36
Loam	284	1.20	0.86	1.00	1.10	1.27	1.50
Clay loam	804	1.33	1.05	1.20	1.29	1.40	1.52
Clay	632	1.24	1.00	1.12	1.20	1.30	1.46
Weighted Mean (all textures)	1884	1.25	0.97	1.11	1.20	1.31	1.47

- The PMP developed by Contour Consulting (2021) identified a historical degradation of the soil through conventional cropping practices and excessive grazing. An area of severe erosion was identified at the head of Yadena Creek. This area is evident as a large area of low carbon soil (brown) on the eastern boundary in the map below.
- In March 2024, the soils on Ridgeview were sampled through FarmLab in accordance with the Emission Reduction Fund soil method, *Estimation of Soil Organic Carbon Sequestration using Measurement and Models) Methodology Determination 2021.*
- Soil Organic Carbon (SOC) was sampled at 0-30 cm and 0-100 cm depth at 27 sample points across the property, excluding areas of dense woody vegetation (CEA* of 1,433 ha). Samples were analysed by APAL.
- Soil organic carbon was found to have a reasonable amount of variation across the property, with an average concentration of **0.59%** at 0-30 cm depth and 0.48% across the whole 0-100 cm profile. Looking at the map below, it is apparent that SOC is more concentrated in areas where soil moisture is likely to be relatively high.
- Total SOC across the whole CEA area was found to be about 16.9 tSOC/ha. This equates to 62 tCO_2e^-/ha or **88,880 tCO_2e-** across the whole CEA to 30 cm depth.
- According to work by the SA Govt., these results would put Ridgeview's SOC% below the 25^{th} percentile for soils in the Upper North District (noting that the District figures are for 0-10 cm soil depth only). This suggests that opportunities exist to increase SOC at Ridgeview, which would most likely to be realised by increasing cover and boosting organic inputs by managing grazing pressure or shifting from grazing to cropping of certain paddocks. If average SOC in the top 30 cm was increased to reach the 25^{th} percentile benchmark for clay loam (1.05%), this would increase the amount of SOC by about 18,880 t SOC (approx. **70,000 tCO_2e^-**).

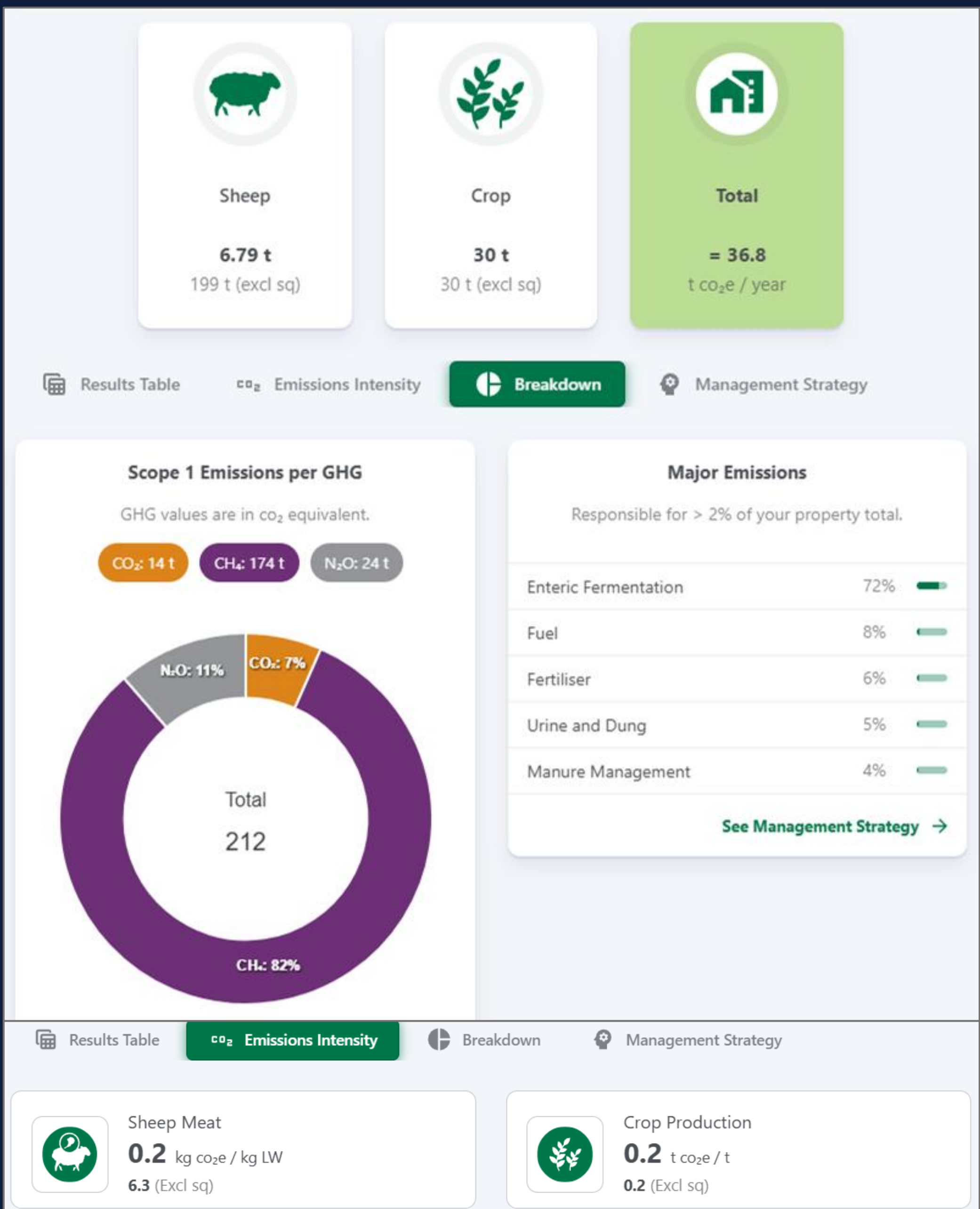


Soil sampling points, CEAs and carbon content for Ridgeview

*Carbon Estimation Area

CARBON FOOTPRINT ASSESSMENT

- The carbon footprint of the Ridgeview operation was assessed using the MLA Carbon Calculator. This assessment included upstream Scope 3 emissions but not downstream Scope 3 emissions (i.e. value stream emissions accounted until the point at which product leaves the farm gate).
- Total gross farm emissions was found to be very low at only **229 tCO_2e^-/yr.** Net emissions were **36.8 tCO_2e^-/yr** (i.e. after subtracting the carbon sequestered by regenerating tall shrubland in the south-west block) .
- Emissions intensity for sheep meat production was **6.3 $kgCO_2e^-$/kg liveweight**. This compares favourably to an Australian industry-wide benchmark of 6.8 $kgCO_2e^-$/kg LW. After carbon sequestered by regenerating vegetation was added to the equation, emissions intensity was only 0.2 $kgCO_2e^-$/kg LW.
- By far the greatest source of emissions was in the form of methane from enteric fermentation and animal wastes, at 82% of total CO_2e^- emitted. Only 8% of total emissions came from diesel and 6% from fertiliser.



VEGETATION CONDITION ASSESSMENT

- The condition of the vegetation communities at Ridgeview was assessed using the “Significant Environmental Benefit” (SEB) survey method.
- Four sites were assessed with varying density of woody cover. Two sites were located in the Broughton IBRA subregion and two in the Olary Spur subregion.
- The highest valuation biodiversity score of **80.37** was achieved by the denser *Acacia victoriae* regeneration block in the south-west. This reflected the good condition of the vegetation in this area, as well as the fact that only 10% native vegetation remains extant in the Broughton subregion, scoring a high 1.22/1.25 for landscape context. 15 species were recorded at the site, including the State-listed rare species, Rohrlach’s Bluebush. Areas of vegetation that occur in blocks also score more highly than those in strips.
- The Seeded Paddock site is also in the Broughton subregion but has been historically overgrazed, in poor condition and is currently destocked to enable recovery. As a result, it did not score highly (**39.6**).
- The Scrub Paddock (**65.67**) and East Scrub (**56.42**) sites scored lower, largely due to the Olary Spur subregion still retaining over 90% of its native vegetation, cultivated land being much less common. The East Scrub community also did not have as good diversity or general condition.
- Though no sites were assessed in the Southern Flinders subregion (north-west of the property), it was apparent that the mature tall shrubland in this area was in poor health, with many individuals dead or dying. This area of vegetation is in the lowest lying part of the property. Dryland salinity tends to occur in the lower parts of the landscape where the topography and water table are closest. It is possible that the historical clearing of deep-rooted vegetation on and in the vicinity of Ridgeview may have caused the local water table to rise, with large mature shrubs subsequently suffering poor health due to their roots accessing saline groundwater.

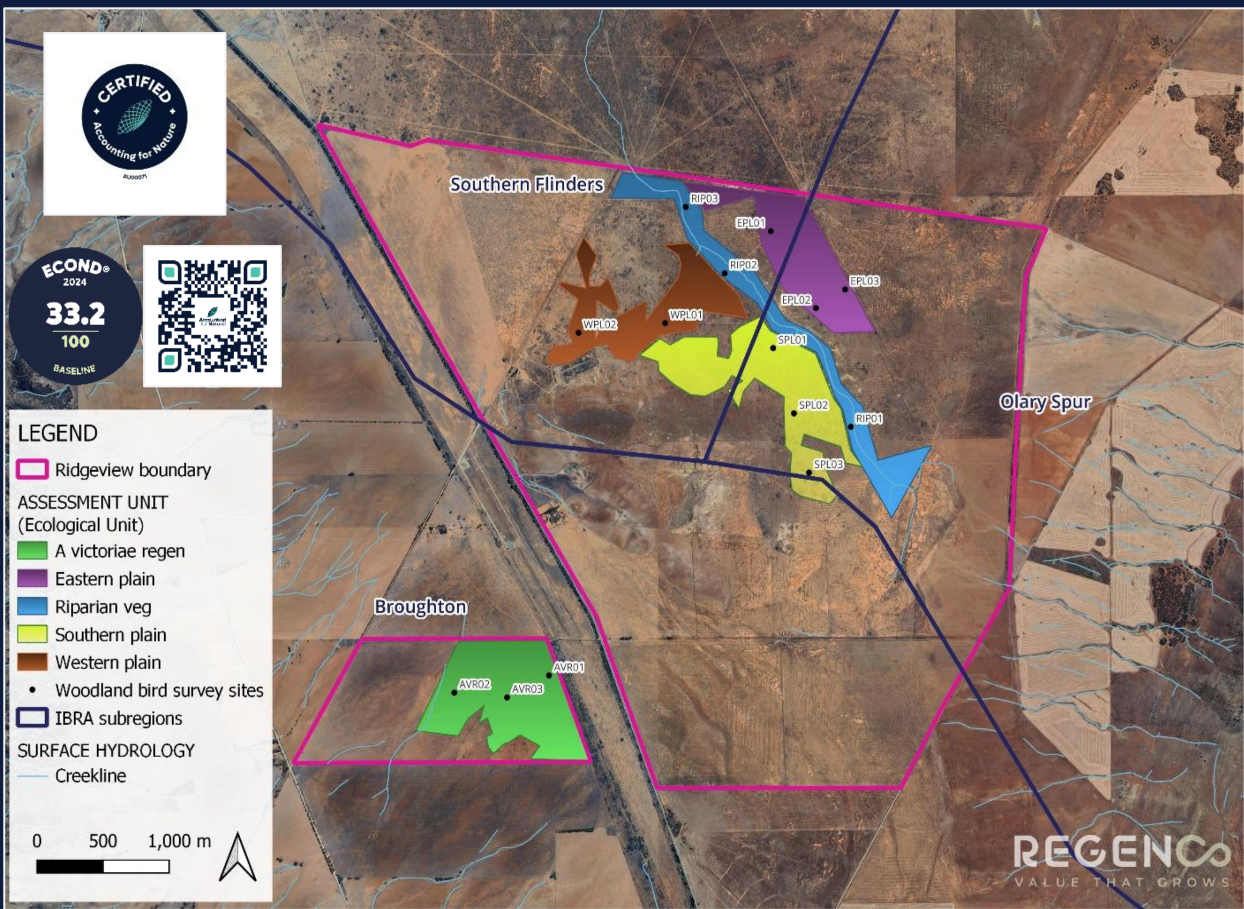
Ridgeview site locations for vegetation condition assessment

REGEN VALUE THAT GROWS

Site	E	N	IBRA subregion	Area	IBRA Assoc.	Biod score
Luckraft A victoriae regen	281822	6368186	Broughton	900	Yongala	80.37
Scrub paddock	284478	6371315	Olary Spur		Terowie	65.67
East scrub	284595	6371270	Olary Spur		Terowie	56.42
Seeded paddock	284346	6369151	Broughton		Yongala	39.6

WOODLAND BIRD ASSESSMENT

- The condition of the woodland bird community at Ridgeview was assessed using the Accounting for Nature (AfN) method, *A native woodland bird assessment methodology for diverse regenerating farmlands* (AfN METHOD F-02).
- Fourteen survey sites were assessed across five strata in the south-west and north of the property. Sites were located in all three IBRA subregions and sampling density was sufficient to be regarded as producing a "High Accuracy" account.
- The condition (Econd®) for the Woodland Bird asset in its entirety was scored as **33/100**.
- The Econd® of the five individual assessment strata were: '*Acacia victoriae* Regen' - 28; 'Riparian Woodland' - 37; 'Eastern Plain Woodland' – 41; 'Southern Plain Woodland' – 41; and 'Western Plain Woodland' – 18.
- Econd® scores for individual survey sites ranged from 17 to 52. Site SPL03 – on the border of Olary Spur and Broughton subregions - was the highest scoring site, with 9 species recorded, 8 of which were small-bodied natives (small-bodied species are indicative of a healthy community).
- No EPBC or State listed species were observed. However, reflecting the regional importance of the remnant tall shrublands found at Ridgeview, six regionally rare and uncommon species were recorded. These included Splendid and Superb Fairy Wren, White-fronted Chat, Rufous Fieldwren, Mulga Parrot and Bluebonnet.
- An active Wedge-tailed Eagle nest was located on the Western Plain, and a colony of Chestnut-crowned Babblers was found on the Eastern Plain with evidence of prior nesting.
- In total, **27 native bird species** were recorded of which 16 were small-bodied
- An ongoing environmental account for woodland birds has been registered and certified by AfN.



3. KEY OPPORTUNITIES: PRODUCTION, CLIMATE RESILIENCE & NATURAL CAPITAL BENEFITS

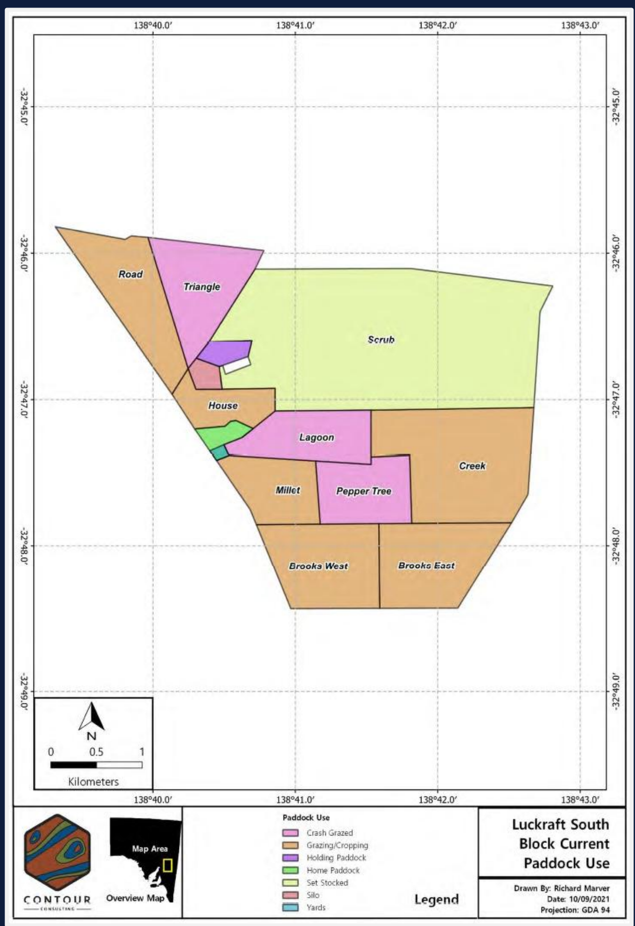
PROPERTY MANAGEMENT PLAN (PMP)

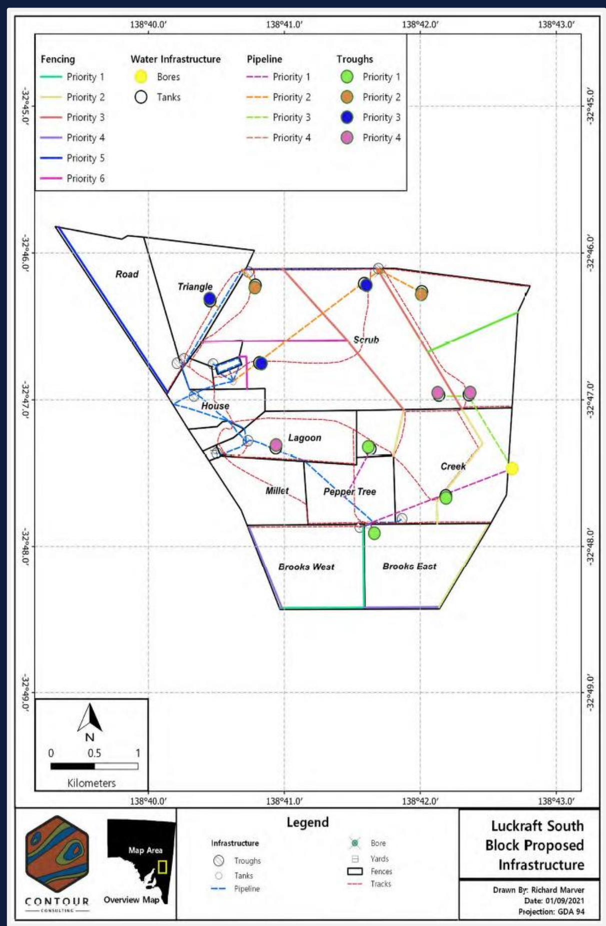
The current Ridgeview PMP identifies continuous grazing and cropping practices as key degrading factors for the property's natural resource base and productivity.

The owners plan to establish a regenerative grazing and management system across the property to allow the rebuilding of soils and rejuvenation of pasture. It is envisaged that Ridgeview will be developed as a lambing property with mobs moved after tailing to other Luckraft-owned blocks.

Broadly the three strategies to be employed are:

- ***Establish a rotational grazing system between and within blocks*** *– This would entail establishing and upgrading a considerable amount of fencing and waterpoint infrastructure (see prioritized infrastructure map below right). It is anticipated that this will promote recovery of perennial native pasture and maintenance of soil cover;*
- ***Rehabilitate soil and pasture*** *- The owners have proposed to establish a plantation of Old Man Saltbush corridors with an improved pasture understorey to supplement feed and provide shelter for lambing. The utilisation of saltbush as a grazing tool will provide management flexibility and sustainability, enabling cover to be better maintained in pasture paddocks that are rested whilst stock are predominantly grazing saltbush. Saltbush rows would be located in currently cropped paddocks (Millet, Creek, Brooks West and Brooks East; see map below left);*
- ***Establish tree shelter belts*** *- The owners propose to establish shelter belts on the southern, western and eastern and dividing boundaries of Brooks East and West paddocks, and the western boundary of Road paddock. Livestock, particularly lambing ewes, are at greatest risk from cold winds and rain which often come from the south or south-west. The shelter belts will work in cooperation with proposed saltbush plantings to provide ample shelter across whole paddocks. The shelterbelts will be multi species and fenced off from stock and may be grazed opportunistically.*





The following pages look at how these actions can support improvement of Natural Capital on Ridgeview and how associated carbon and biodiversity projects may be leveraged to expand and expedite PMP delivery while enhancing farm productivity, resilience to climate change and biodiversity.

TREE SHELTERBELTS & BLOCK PLANTINGS

Production System Benefits

The climate information provided above shows that a major risk to the Ridgeview operation is posed by climate, which is already challenging for sheep production and will only become more so under projected changes. Shelterbelts are a significant tool for mitigating these risks.

Wind chill: The information below, taken from a South Australian Government factsheet, is highly relevant to Ridgeview and the opportunity presented by shelterbelts to improve weight gain and survival, particularly in late winter when rain and wind chill are a major risk.

The benefits of shelterbelts

Research has shown the beneficial effects of shelterbelts on farm productivity.

The main benefits for landholders in southern Australia are:

1. Young lambs with shelter have a greater survival rate than those without.
   - Shelterbelts can increase survival of young lambs in their first 48 hours from 84% to 93% for single lambs (Bird et al, 1984).
   - The increase in survival is even larger for twins, where shelterbelts have been shown to increase survival from 56% to 78% (Bird et al, 1984).
   - The bottom line $: For a flock of 2,000 ewes where half have a single lamb and half have twins, these percentages mean an extra 530 lambs surviving per year!
2. Shelterbelts can reduce water loss in pasture plants particularly in spring and summer, which extends growing conditions.
   - Although there can be a loss of productivity close to a shelterbelt, gains in productivity have been shown in plant production at a distance of 2-18 times the height of the shelterbelt into the paddock.
   - This positive effect is due to wind speed reduction and temperature modification resulting from the shelterbelt.

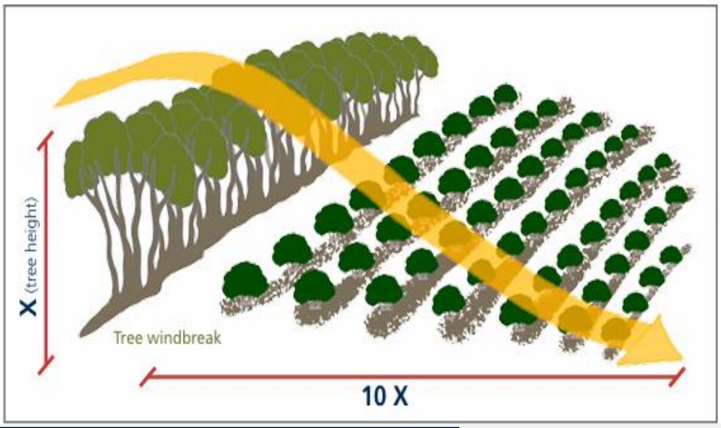


Figure 1. Protection offered by shelterbelts. *(adapted from the Goolwa to Wellington Local Action Planning Association Inc. Shelterbelt factsheet)*

Exposure can be fatal for lambs

Research on Kangaroo Island found that winds as light as 8 km per hour, in combination with 0.25-5 mm of rain per day, significantly increase mortality in Merino and Corriedale lambs. Higher winds (24-56 km per hour) combined with more than 5 mm of rain per day increased lamb mortality in Merinos by over 50% (Obst and Day, 1968).

Newborn lambs are most at risk. Further research on Kangaroo Island found that in the first six hours after birth (critical post-birth period), lamb losses were 5–10% if there was no rain and wind was less than 8 km per hour. However when wind was greater than 18 km per hour and more than 1.5 mm of rain was received in the critical post-birth period, lamb losses could exceed 70% (Obst and Ellis, 1977). In 2012, lamb deaths from exposure made the headlines, and it was estimated that up to 15 million lambs are dying within 48 hours of birth in Australia every year (The Australian, 2012). This results in large financial losses to sheep producers each and every year.

Post-shearing is a time of risk

For 14 days after shearing, adult sheep can be at risk of hypothermia if exposed to cold winds and rain. Sudden adverse weather events and unseasonal cold weather are the main cause of stock losses post-shearing. In South-West Victoria for example, unseasonal cold weather in March 1983 caused around 30,000 sheep to perish when a storm resulted in wind speeds of 32 km per hour, rainfall of 42 mm and a temperature drop to 16°C (Bird et al, 1984).

Wind affected pastures

Research indicates that high wind speeds increase water loss through transpiration in grasses and clovers leading to a reduction in growth (Radcliffe, 1983). In extreme cases, damaging winds can cause physical damage to plants through mechanical agitation (Sturrock, 1981).

Liveweight gain and heat stress: Goulburn Broken Catchment Management Authority also produced a factsheet that highlighted the value of shelterbelts to improving sheep liveweight gain, wool production and health under conditions likely to provoke heat stress, as below:

Shelter benefits:

- Ewes exposed to 32+°C after joining have a 40.7% fertilisation success
- Heat stress reduces conception rates in sheep. Refer to figures shown below

Breed	Sheltered (marked per ewe lambed)	Unsheltered (marked per ewe lambed)	Difference Extra Lambs/100 ewes
Merino	126%	102%	24
Coopworth	157%	139%	18

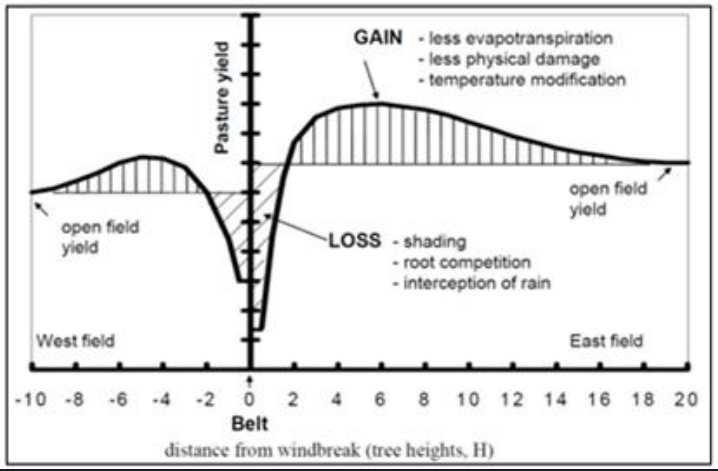
- ✓ Shelter increases pasture growth by 10% and sheep require 10% less pasture to maintain body heat in cold conditions when shelter is available. The combined effect of these benefits is expected to generate on average an extra $0.93/DSE per year.
- ✓ Heat load reduction on ewes at joining and lambing results in lambs with faster growth rates and more wool during their first 16 months of life. Heat stress reduces wool growth by reducing feed intake.
- ✓ Sheltered sheep showed a 31% increase in wool production and a 21% increase in live-weight in a five year trial.
- ✓ Sheltered off-shear wethers require only 1/3 the supplementary feed as unsheltered stock.
- ✓ Heat stress is detrimental to ram fertility, ovulation rate and conception in ewes and foetal development.

TREE SHELTERBELTS & BLOCK PLANTINGS

Production System Benefits

Pasture production: The Basalt to Bay Landcare Network collated a document titled "*The Economic Benefits of Native Shelterbelts*". This included information about the benefit of shelterbelts to pasture production, as follows:

- Shelter improves plant growth and increased pasture and crop production, by reducing moisture loss from soils and transpiration in crops and pastures.
- On one farm sheltered areas had a 20% increase in average annual pasture growth.
- Major gains in decreased animal stress and greater pasture production in winter can support an extra 1-3 sheep/ha.
- Gross value of pasture output is at its highest level when the proportion of tree area on a farm is at 34%.
- There is growing evidence that soils around trees contain elevated amounts of organic material and a higher nutrient status, thereby promoting pasture growth.
- Sheltered pastures lose 12mm of water less than open pastures during the spring growing season.
- There is no major evidence to indicate a large effect of shelter on pasture growth. Losses in the competitive zone are matched by an equivalent gain in the sheltered zone.



Estimated economic benefits: The Basalt to Bay collation also included an analysis by Patrick Bird (1996) of the estimated percentage gains and associated economic translation of several of the benefits outlined above. These benefits were estimated for two different spacings of shelterbelts – 250 m and 500 m, as below.

Table 1. Expected benefits from shelterbelts at maturity

Benefit	Belts 500 m apart	Belts 250 m apart
Wind speed reduction:	33%	50%
Improved plant growth: resulting in extra production (gross margin $ per ha)	+ 10% + $16	+ 20% + $32
Reduced maintenance energy requirement of stock: resulting in extra production (gross margin $ per ha)	+ 10% + $16	+ 17.5% + $28
Improved lamb survival (extra % units weaned): resulting in extra production (gross margin $ per ha)	+ 5% + $3	+ 5% + $3
Reduced losses of shorn sheep (ave. annual %): resulting in extra production (gross margin $ per ha)	+ 0.5% + $1.50	+ 0.5% + $1.50

Benefits from shelterbelts at maturity (Source: Bird 1996).

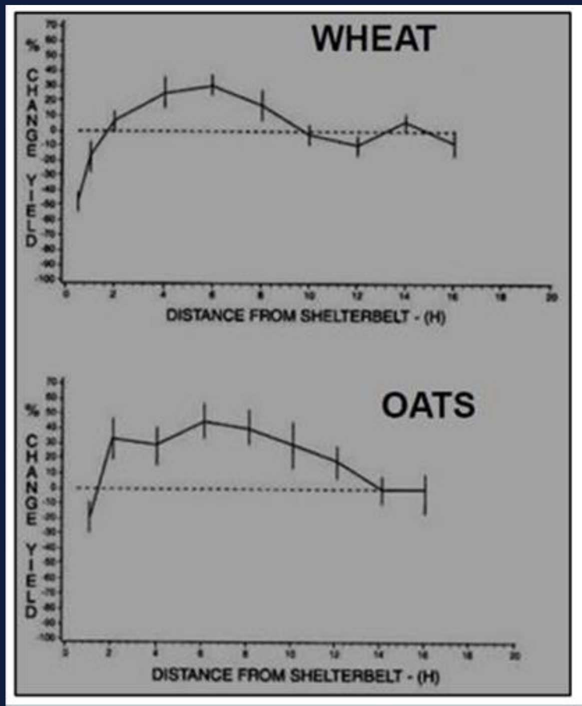
Note: As these estimates were devised 30 years ago for SW Vic. sheep farmers, the applicability of the economic estimates to the Upper North District in 2025 may be tenuous. Nonetheless, they provide a guide to the scale of benefits offered.

TREE SHELTERBELTS & BLOCK PLANTINGS

Production System Benefits

Crop yields: The Basalt to Bay document also addressed benefits to grain crops, providing the following information from various sources:

- Shelterbelts increase crop yields, even allowing for cropping land lost from paddock and near-shelter competition.
- Shelterbelts can potentially be effective for a distance 12-15 times the height of the tallest tree, with protection of some crops observed at up to 25 times the height.
- Increases in crop yields in Australian studies include: 22% for oats, 47% for wheat in areas of above 600mm annual rainfall.
- Sand-blasting at seedling stage of cereal crops leads to reduced plant growth, due to moisture stress and physical damage.
- An increase in Lupin yield of 27% was recorded between windbreaks.



Research conducted on Yorke Peninsula (Amato, 2025) found that canola and faba bean yield increased with remnant vegetation within a 200 m radius due to increased pollination:

- Agricultural landscapes with higher proportions of complexity and habitat quality are generally associated with greater pollinator richness and abundance.
- For beans, distance to vegetation had the greatest influence on maximum pollination, whereas the area of fragment and linear vegetation within 200 m had a greater effect on maximum pollination of canola.
- Large areas of linear and fragment vegetation that are close to crops could promote maximum pollination and, therefore, increase total yields.
- Results suggest that optimising bean and canola productivity requires the protection of both fragment and linear vegetation, since configurational heterogeneity affects pollination success.

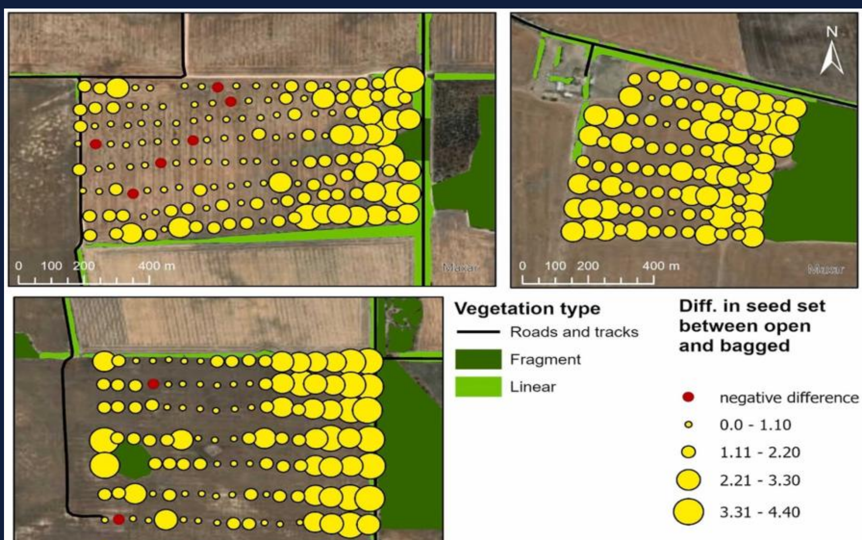


Fig. 5. Increase in seed set between bagged and unbagged plants of *Brassica napus* (response variable) and fragment and linear vegetation (explanatory variables) from the three sites.

TREE SHELTERBELTS & BLOCK PLANTINGS

Natural Capital Benefits

The next section of this report (4. *Project Proposal & Business Case*) presents a design and business case for a potential 200 ha shelterbelt and block planting project. This expands quite considerably on the scale of shelterbelts proposed in the current Ridgeview PMP. The reasons for this are:

- A project of this scale may achieve a carbon yield sufficient to underpin a viable carbon project that could potentially be registered under an appropriate method of the Australian Government's Emission Reduction Fund to earn Australian Carbon Credit Units (ACCUs).
- A total planted area of 200 ha, when added to the existing area of woody vegetation on property of about 320 ha, would increase the tree area on farm to just under 30%, a figure that approaches the "optimal area" for gross value of pasture output, according to the information provided on Page 22.
- The diversity, scale and spread of plantings proposed would take advantage of the property's biophysical attributes to maximise biomass accumulation while offering a diverse array of both built and natural infrastructure that will increase the sheltered microclimates, flexibility and resilience of Ridgeview's production system.

In addition, a planting project of this scale will improve the Natural Capital of Ridgeview in a number of ways that will add to, interact with and enhance the potential production benefits described on the previous pages:

Vegetation biomass carbon – The proposed shelterbelt plantings are modelled to sequester carbon at an estimated average annual rate of about **1,420 tCO_2e^- /yr** over 25 years, accumulating about **35,500 tCO_2e^-** in that timeframe.

Soil carbon – The shelterbelts will help to increase soil carbon on Ridgeview both directly, through reduced wind erosion and increased addition of carbon in leaf litter, and indirectly, through provision of microhabitats with lower wind and higher soil moisture allowing higher groundcover to be maintained and loss of soil carbon by exposure to be reduced.

Vegetation condition – The shelterbelts will enhance the condition of the existing native vegetation by increasing biodiversity and connecting large areas for enhanced genetic flow and self-organization. The block planting is proposed to be established adjoining the regenerating *Acacia victoriae* block in the Broughton sub-region, which will more than double the area of this high value environmental asset. There is also an option to protect this area with kangaroo-proof fencing to facilitate high-level control of grazing pressure and maximise biodiversity and health of the ground layer vegetation.

Woodland Birds and other fauna – Restoration promotes recovery of woodland birds in agricultural landscapes (e.g. Bennett et al, 2022) and connectivity is key to this. The proposed shelterbelts will greatly enhance connectivity between the blocks of shrubland in the south-west and north of the property, as well as between the three IBRA sub-regions. It is proposed to make corridor plantings at least 30 m wide to enhance their habitat value. One study referred to by Basalt to Bay found that an average shelterbelt (3 rows/12m wide) can promote 12 species of woodland bird; if widened to 25m (7 rows) the number rises to 17. Bird diversity will also be enhanced by high floristic diversity and structural complexity of shelterbelts (Bonifacio et al, 2011) and by linking to the stands of existing mature vegetation (Haslem et al, 2020). By bolstering populations of woodland birds, along with other fauna such as pollinating and predatory insects, ecosystem services to adjacent crops and pastures will be enhanced. The block planting will be an important driver for increasing fauna biodiversity, as the bird and insect species that inhabit corridor plantings are known to be substantially different from those that inhabit large blocks of vegetation. It is proposed to include mallee eucalypt species in the plantings, which have been substantially cleared from the plains of the local region – these species will return a suite of resources to the landscape for birds and other fauna.

Water – The shelterbelt plantings will help to keep the water table on Ridgeview from rising too high and causing salinization of the north-west corner. Plantings may also help to manage the erosion area identified in the PMP at the upstream end of Yadena Creek. Plant Available Water in soils will be enhanced due to decreased wind speeds in the sheltered zone leading to reduced evaporation rates and, indirectly, due to increased soil carbon levels leading to higher water holding capacity. It has also been shown that woodland trees enhance water infiltration in fragmented agricultural landscapes, reducing "ecosystem leakage" and potential soil erosion in intense rainfall events (Eldridge, 2005).

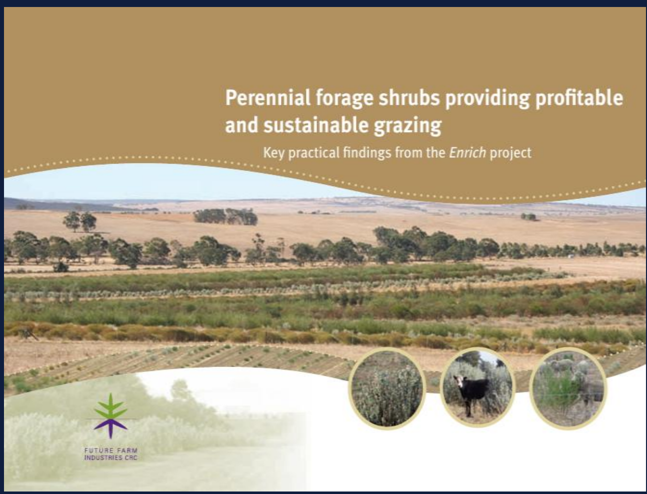
FODDER SHRUB CORRIDOR PLANTINGS

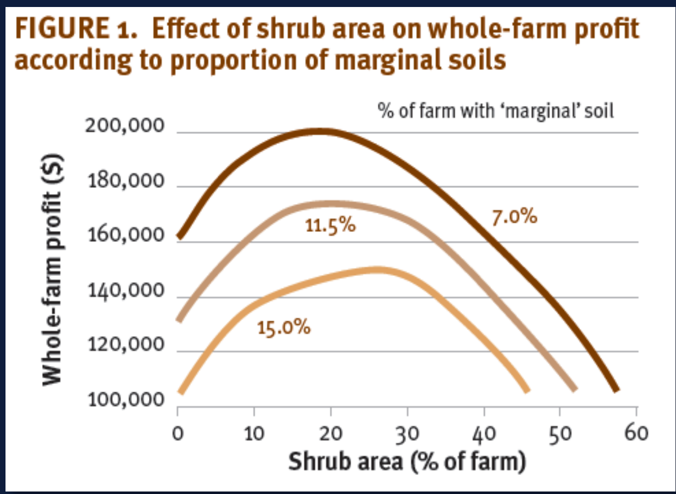
Production System Benefits

The *Enrich* research project conducted in the 300 – 350 ml rainfall zones of SA, WA and NSW (including sites near Orroroo) was initiated due to an emerging awareness that prolonged drought and changes in rainfall patterns were making land use dominated by cropping and annual pastures unsustainable, especially in medium to low rainfall areas. These events presented an opportunity for large-scale change to livestock industries, where blending feed production from woody and herbaceous perennials with traditional pastures could become the preferred productive and less risky land use for the future.

Enrich looked at some guiding principles for incorporating forage shrubs into grazing systems, including the optimal area of a farm established to forage shrubs; grazing time for optimal use; scale and layout; plant establishment and productivity; and nutritive value traits of various species.

The headline finding was that "*For a 'typical' farm in low-medium rainfall crop-livestock zones of Southern Australia, inclusion of perennial forage shrubs at about 10-20 % of farm area can increase profit by 15-20 %*"





Given the above, Ridgeview would benefit from planting Old Man Saltbush (OMS) and other fodder shrubs across 400-500 ha of the property. This aligns with current plans to establish OMS corridors across the following paddocks that are currently opportunistically cropped – Brooks East, Brooks West, Millet and Creek Paddocks.

The Enrich project examined 101 species with potential for use as forage for livestock in semi-arid Australia, not just for palatability but also:

- Edible biomass
- Plant growth over time.
- Growth form and height.
- Re-growth after grazing.
- Nutritive value (protein fibre, minerals).
- Effects on rumen fermentation (gas production to indicate digestibility).
- Bioactivity — pattern of rumen fermentation end products including methane, ammonia, volatile fatty acid composition.
- Bioactivity — anthelmintic properties.

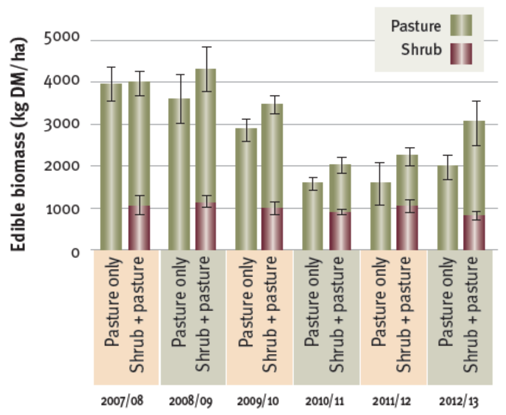
FODDER SHRUB CORRIDOR PLANTINGS

Production System Benefits

Forage production: During six years of research under *Enrich*, greater annual productivity was achieved with the addition of forage shrubs:

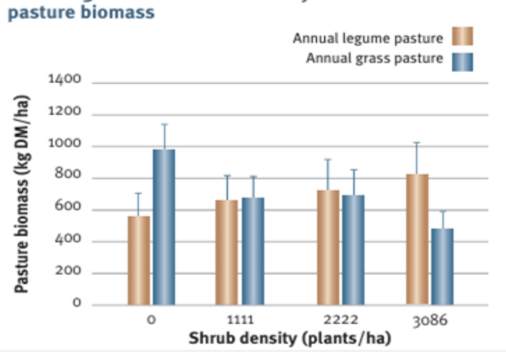
- Forage shrub production was stable from year to year and contributed around 1000 kg/ha. This ‘extra’ tonne in autumn is higher in crude protein and mineral content than the inter-row pasture of annual plant species, which are dead at this time of year. Animals can only utilise fibre in senesced pasture and crop stubbles if they have a source of nitrogen. Forage shrubs provide this useful dietary complement.
- Demonstrated the growth of annual pasture legumes is not compromised when grown alongside shrubs. While annual grass production is reduced with high shrub density, at moderate shrub density (for example, <1000 shrubs/ha), the loss of grass biomass is compensated by the increase in shrub edible biomass.
- Shrubs reduce supplementary feeding during the summer/autumn feed gap, and are particularly valuable forage in winter if there has been a late seasonal break and pasture growth is slow.
- Shrubs may enable deferral of grazing other paddocks at the break-of-season, allowing better winter pasture establishment.

FIGURE 2. Annual forage production measured as spring and autumn annual pasture biomass and including autumn shrub biomass for the shrub and pasture system*



* Shrubs were planted at a density of 2066 plants/ha

FIGURE 3. Effect of shrub density on inter-row pasture biomass

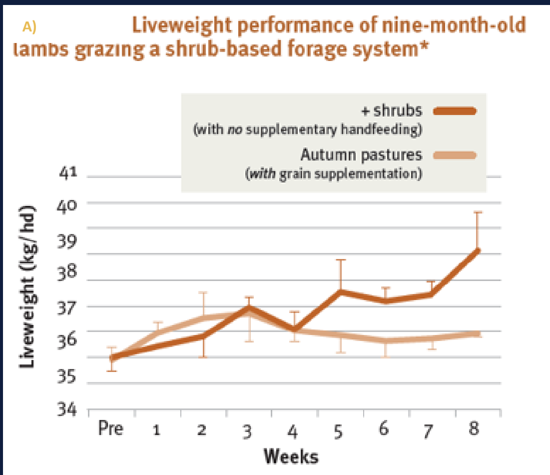


- The shade provided by shrub species can create favourable soil moisture conditions through reduced evaporation and lead to better pasture survival in conditions such as false breaks. Annual pasture species remain green for longer at the end of the cooler growing season when afforded some protection by shrubs.
- During winter, minimum temperatures are higher within shrub stands and frosts are less common.

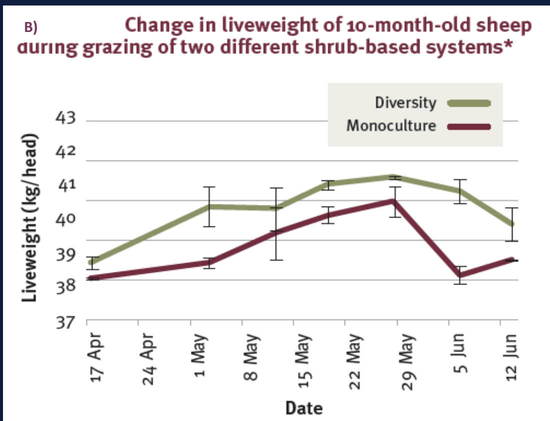
Shelter and shade: *Enrich* found that rows of a mixture of tall and shorter species are the best way to achieve even permeability and adequate height. Using just tall species can lead to increased wind speed under trees where livestock have grazed all the lower branches. Suggestions of species suitable for shelter provision are provided below, with species also providing good shade indicated by an asterisk. Note, the listed species are not necessarily all suitable for planting at Ridgeview. Seek local expert advice.

Shorter	Medium	Tall
Atriplex nummularia (old man saltbush)	*Acacia ligulata* (sandhill wattle)	*Acacia loderi* (nelia)*
Atriplex rhagodioides (silver saltbush)	*Acacia oswaldii* (Oswald's wattle)*	*Acacia neriifolia* (oleander wattle)
Rhagodia parabolica (mealy saltbush)	*Acacia saligna* (golden wreath wattle)*	*Acacia pendula* (myall)*
Rhagodia preissii (mallee saltbush)	*Allocasuarina verticillata* (drooping sheoak)	*Geijera parviflora* (wilga)*

FODDER SHRUB CORRIDOR PLANTINGS



* Five shrub species — old man saltbush, rhagodia, river saltbush, ruby saltbush and tar bush — with an inter-row of sown pasture, including barley and a mix of other grasses



* The first system (Diversity) was a diverse mixture containing 20 shrub species plus senesced volunteer pasture, and the second (Monoculture) was comprised of only one shrub species plus senesced volunteer pasture. Both systems were grazed at 20 sheep/ha over six weeks during autumn. The contribution of shrubs to the actual diet eaten was much greater in the diverse system throughout the whole grazing period.

Production System Benefits

Liveweight gain: Enrich examined and compared the liveweight gain of lambs grazing a) a shrub-based forage system vs autumn pastures with supplementary grain, and b) a diverse shrub-based system vs one with inly one shrub species. The study found that weight grain was greater in a) the shrub-based forage system and b) the diverse system.

Given the wealth of information gathered by Enrich on shrubs other than OMS, it is recommended that the landholder considers desired traits for shrubs in their forage system and incorporates a diversity of shrubs in the plantings.

The booklet *Perennial forage shrubs – from principles to practice for Australian farms* provides an easily accessible resource for understanding the attributes and assisting selection of 10 of the most likely forage shrubs for semi-arid grazing systems. The detailed final project report for *Enrich* can be found here

Economic and other considerations: *Enrich* provided a brief list of economic and other considerations if interested in establishing forage shrubs on farm, as follows:

What you're up for:

- 500–1500 plants per hectare (depending on your layout)
- $0.30 + per plant, depending on species and source (contact your local nursery)
- Weed control at establishment
- Planting costs (yourself or a contractor)
- Start small, identifying areas where you are keen for a new option for profitable land use, and consider building up towards about 10% of the farm area to optimise the benefits of having perennial shrubs in your feed base.

Expect establishment to be in the order of $250–450/ha

What you get back:

- 500–600 grazing days/ha that are available at a time of year where feed supply and quality are often limiting productivity
- A forage resource that lasts at least 15 years (which means the high up-front costs provide a return over a long period of time)
- Management flexibility by an additional forage resource, allowing deferred grazing on other parts of the farm
- NRM benefits (e.g. reduced risk of wind erosion, potential reservoir for desirable invertebrates as part of integrated pest management).
- Increase in whole-farm profit (economic modelling indicates it can be as high as 20%), or maintenance of whole-farm profit with less area cropped (providing you with a risk management tool).

Note, the *Enrich* publication was produced almost 15 years ago, so the economic estimations provided may be somewhat out of date.

FODDER SHRUB CORRIDOR PLANTINGS

Natural Capital Benefits

As with the proposed shelterbelts, the planned fodder shrub plantings will support Natural Capital gains, which will, in turn, interact with and bolster farm system productivity and resilience:

Vegetation biomass carbon – A study of carbon mitigation using Old Man Saltbush plantings (Walden et al, 2017) was undertaken at six sites in southern WA, SA and NSW with similar climate to Ridgeview. The study found that OMS plantings sequestered between 0.2-0.6 tC/ha/yr, which equates to 0.73-2.2 tCO_2e^-/ha/yr. For the purposes of the exercise, we adopt a conservative figure of 1 tCO_2e^-/ha/yr for Ridgeview. The landholders have indicated that they are looking to ultimately plant out about 500 ha to OMS. This area is estimated to have sequestration potential of **500 tCO_2e^-/yr**. Walden (2017) confirmed that OMS shrubs continue to sequester carbon for at least 13 years. So, using that figure, over 13 years the proposed Ridgeview plantings are estimated to sequester **6,500 tCO_2e^-** in total. Currently there is no Australian method that lends itself to generating carbon credits from forage shrub plantings, but the sequestered carbon could potentially be used to inset against farm emissions for carbon neutral claims.

Soil carbon – The Walden (2017) study compared soil carbon in OMS plantings to adjacent pasture and found no significant difference. However, the proposed carbon plantings at Ridgeview are proposed for paddocks that are currently opportunistically cropped. If the inter-row of the fodder shrub plantings is transitioned from cropping to a grazing system, this will likely result in a reliable increase in soil carbon. Modelling by FarmLab gives a rough estimation of 0.44 tCO_2e^-/ha/yr for crop to pasture conversion in the Upper North Agricultural District. Therefore, over 500 ha, the fodder shrub area may sequester **220 tCO_2e^-/yr** just through this land use change. This carbon could, once again, be used as an inset against farm emissions for carbon neutrality.

In addition to the management change from cropping to grazing, the fodder shrub corridors will help to increase soil carbon on Ridgeview through provision of microhabitats with lower wind and higher soil moisture allowing higher groundcover to be maintained and loss of soil carbon by exposure to be reduced. The *Enrich* project also found that nitrogen-fixing legumes tend to grow well as a companion pasture to fodder shrubs, and the presence of shrubs brings increased nutrient cycling with companion pastures having higher levels of phosphorus and potassium. Therefore, soil nutrient constraints to pasture growth many be overcome in the inter-row of a diverse fodder shrub system, resulting in greater SOC being generated.

Carbon footprint – Ridgeview's carbon footprint shows that by far the largest source of its carbon emissions is enteric methane production in sheep. Fodder shrubs present an opportunity to reduce emissions from this source by including tar bush (*Eremophila glabra*). Tar bush, a local shrub species has been shown to influence the conditions and fermentation profiles in the rumen, such as producing less methane (waste) when digested compared with other forages. Laboratory tests indicate reductions in methane production of more than 80% (Durmic et al, 2022). This would equate to **132 tCO_2e^-/yr** at current stocking rates. Tar bush has also been able to mitigate acidosis in sheep rumen.

Vegetation condition – The fodder shrub corridors will enhance the condition of the existing native vegetation by increasing biodiversity and connecting large areas for enhanced genetic flow and self-organization. Planting a diverse range of fodder shrubs, rather than a monoculture of OMS, will further enhance this value.

Woodland birds and other fauna - Adding shrubs creates a new vegetation layer, resulting in increased biodiversity compared with simpler agricultural landscapes. Increased numbers of birds and reptiles are found in forage shrub plantations compared with annual pasture systems. The forage shrub species detailed in the *Enrich* booklet also host beneficial predatory insects offering potential advantages for pest management in nearby crops and pastures. A study (Collard et al, 2011) conducted in South Australia examined selected ecological indicators, including plant and bird communities, in saltbush plantings, nearby areas of remnant vegetation and improved pasture. In general, remnant vegetation sites had higher biodiversity values than saltbush and pasture sites. However, saltbush sites did contain a diverse range of plants and birds, including a number of threatened bird species not found in adjacent pasture

Water - OMS and other fodder shrubs' extensive root systems, coupled with their perenniality, enable them to reduce risk of dryland salinity through greater use of water from deep in the soil profile.

ROTATIONAL GRAZING SYSTEM

Production System Benefits

The PMP for Ridgeview advocates the adoption of a rotational grazing system. Anecdotal and (some, but not all) experimental evidence suggests that there are a number of production benefits to transitioning from a continuous grazing system to a rotational one. The PMP explains:

> *A rest-based grazing system will provide the most amount of benefit to the productive species within the properties. A short, heavy graze period applies the same level of grazing pressure to an area as a long, light graze period, while maximising the length of the rest period. This will result in a healthier root system, and a more resilient tussock that has a better chance of surviving long dry spells (Figure 10.1 and Figure 10.2)…. Increases in perennial grasses offer more feed towards the end of the dry season, thereby increasing the overall carrying capacity of the areas. Research on long term grazing trials at Old Man Plains (OMP) research station, Alice Springs, has shown that over a ten year period, by rigorous determination of appropriate annual stocking rates and with the introduction of pasture resting, rangeland condition was improved and rainfall use efficiency improved by a factor of 2.5 in terms of kg Dry Matter (DM)/ha/yr/mm rainfall. These improvements came largely from regenerating populations of native perennial grasses.*

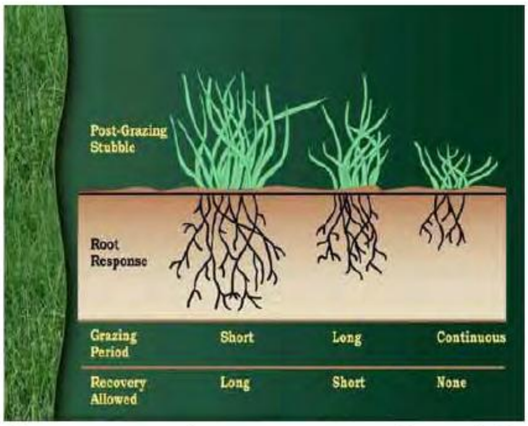


Figure 10.1: Plant response to grazing periods of different lengths (Colorado State University 2013).

Figure 10.2: Continuously grazed grasses will have small root systems (Australian Wool Innovation and Meat and Livestock Australia 2009).

Given projected declines in annual rainfall and increasing evapotranspiration, improved rainfall use efficiency of the pasture resource would be a critical benefit for the sustainability of the Ridgeview grazing operation. Also, the return of historically overgrazed and now sparse summer-active perennial grasses would help to adapt the production system to observed increases in summer rainfall events. Currently the property has poor capacity to take advantage of late summer rain.

Other reported benefits of rotational grazing include even grazing pressure; reduced herbivore selectivity and selection of most palatable species; enhanced flowering, growth and survival of plant species; improved pasture utilization; maintenance of pasture cover; increased herbage production; increased perennial basal area; reduced soil erosion and improved animal production.

The length of the rest time relative to the graze time can also be influential. McDonald et al (2019) found that increasing the length of rest relative to graze time under strategic-rest grazing was associated with an increase in plant biomass, ground cover, animal weight gain and animal production per hectare when compared to continuous grazing.

Natural Capital Benefits

Continuous livestock grazing can have negative effects on biodiversity and landscape function in arid and semi-arid rangelands. Alternative grazing management practices, such as rotational grazing, may be a viable option for broad-scale biodiversity conservation and sustainable pastoral management (McDonald et al, 2019). The adoption of a more rotational grazing system at Ridgeview may offer natural capital benefits as follows:

Vegetation biomass carbon – Some studies have found that rotational grazing can improve the biomass of pastures. For example, Lawrence at al (2019) found that pastures under rotational grazing management were characterised by increased cover and depth of plant litter and greater retention of pasture biomass, while McDonald (2019) found that biomass only became greater under rotational grazing when a rest:graze time greater than 6:1 was applied. Badgery (2017) found that intensive rotational grazing with a 20-paddock flexible system was able to increase pasture growth of a native pasture by 21%. Therefore, although this report does not estimate uplift of biomass carbon via rotational grazing, we can reasonably expect gains in the Ridgeview pastures with this practice change, which is likely to support improved landscape function (e.g stabilize soil, provide a buffer from extreme temperatures, reduce soil erosion, improve infiltration and contribute to nutrient cycling through the decomposition and mineralization of plant material).

Soil carbon – McDonald et al (2023) conducted a wide review of research into the impacts of grazing management on SOC in Australia, finding that most studies reported no significant difference in SOC between grazing management treatments. This is despite key drivers of soil carbon sequestration being favoured by rotational gazing, including above and below-ground biomass, plant growth rate, groundcover, soil structure and soil nitrogen. Similarly, in the vicinity of the Upper North Agricultural District, a study by Sanderman et al (2015) found a significant positive trend of increasing NDVI (plant growth) under rotational grazing relative to continuous grazing but no significant difference in SOC stocks. Therefore, while this report makes no attempt to estimate a change in soil carbon for Ridgeview under rotational grazing, the practice change will help to create the conditions that make soil carbon sequestration more likely.

Vegetation condition – Rotational grazing can improve the condition of pasture species by reducing selective grazing and allowing recovery of preferred plants after grazing. A study by McDonald et al (2019) found few differences in plant biodiversity and ground cover between a rotationally grazed property and a nearby ungrazed nature reserve (despite differences in overall plant species composition), suggesting that rotational grazing may have potential to sustain some elements of biodiversity and ground cover on pastoral properties. It is expected that incorporating more rest into a multi-paddock grazing system, which includes fodder shrub corridors, will help recover some favoured pasture species reduced by past grazing practices, especially summer-active native perennial grasses (e.g. Ampt and Doornbos (2010)). However, it should be noted that semi-arid pastoral resources can be slow to recover from past degradation.

Birds and other fauna – By moving towards a grazing system that incorporates longer periods of rest, ground cover vegetation at Ridgeview will become more functionally diverse in composition and structure, with some areas recently grazed short with low cover and others with greater cover and biomass/height after a period of prolonged rest. This increased structural and floristic diversity in the ground-layer will add to that provided by the addition of fodder shrub corridors and tree shelterbelts to greatly increase habitat heterogeneity in all vegetation strata across Ridgeview. Vegetation heterogeneity has been identified as a key element in promoting bird and other biodiversity on farms, with rotational grazing being highlighted by Toombs et al (2010) as a key way to achieve this. Generally speaking, the increased standing biomass and ground litter provided under rotational grazing management will also offer superior habitat for small animals including invertebrates, birds, reptiles and small mammals.

Water – Rotational grazing offers the benefit of improved water infiltration and rainfall use efficiency. For example, a report by Ampt and Doornbos (2011) found that properties under rotational grazing management in NSW achieved results for a water infiltration indicator that was 40% higher than the continuous grazing comparison sites. Achieving a similar outcome at Ridgeview will enhance pasture growth and help control erosion.

4. POTENTIAL PROJECT & BUSINESS CASE

DISCLAIMER: The information provided in this section of the report does not constitute a business offer, nor does any other part of this report. The environmental & carbon related findings and recommendations given in this section are specific to "Ridgeview", however the financial information that has been used to demonstrate indicative revenue and costs is of a general nature only. RegenCo recommends that independent legal and financial advice is sought prior to entering into any commitment.

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ENVIRONMENTAL PLANTING PROJECT

Design

The map below presents a proposed configuration for an Environmental Planting project, that could potentially be registered under the Australian Carbon Credit Unit (ACCU) Scheme for the generation of ACCUs. Key features of the proposed 200 ha project are:

Block planting - A 73 ha planting in the south-west corner of the property. The planting is located near the break-of-slope of Narien Range and, as such, is in an area of relatively high topographic wetness where tree growth rates are more likely to be high. The area could be planted as an open mallee eucalypt-acacia woodland with a perennial grass understorey, protected from abundant resident kangaroos and occasional passing goat herds by a 5 km exclusion fence, for maximum control of grazing pressure. Once plantings have matured, this would be a valuable and reliable asset for time-managed grazing of stock, while helping to ecologically connect Narien Range to its adjacent plain and return native woodland to the Broughton sub-region.

Fenceline shelterbelts - The project would establish all fenceline shelterbelts planned under the current PMP with some additional shelterbelts proposed. Covering 79 ha, the shelterbelts would be 30 m wide to maximise ecological value and effectiveness in providing shelter and shade to stock. The double-fenced areas would be large enough to occasionally allow stock in for crash-grazing, once plantings have matured. In association with the shelterbelts, about 30 km of new fencing would be established, including all Priority 1, 2,4 & 5 and some Priority 3 fencing identified in the PMP. These new fences would enable substantial progress towards the goal of establishing a flexible and effective rotational grazing system.

Drainage line shelterbelts - The proposed drainage line shelterbelts, covering 30 ha in the south and central-west of the property, would take advantage of mostly subtle drainage lines, and a few more prominent gullies, to establish 40 m wide shelterbelts. This topographic location offers the greatest chance of avoiding planting failure due to drought. Running predominantly in a SE to NW direction, these shelterbelts are well orientated to mitigate the prevailing strong, south-westerly winds that pose the greatest wind chill risk to lambs and pregnant ewes in late winter-early spring. It is proposed that these plantings would be unfenced and that they would be able to establish at the same time as fodder shrub corridors, especially in Brooks East and West paddocks (to the south).

Connecting shelterbelts - 18 hectares of 40 m wide connecting shelterbelts are proposed for planting in a south-west to north-east direction in Brooks East and West paddocks. The cross-hatching of these with the drainage line shelterbelts will effectively create sub-paddock areas sheltered from winds in all directions. They will also provide a valuable ecological service as connecting corridors between the block planting/existing tall shrubland in the south-west of the property and the creek, wetland and large Acacia-Myoporum shrubland to the north. Floristic and structural diversity will be prioritized in these plantings. As above, fencing is not proposed.

Ridgeview topography, hydrology, existing vegetation and proposed Environmental Plantings

ENVIRONMENTAL PLANTING PROJECT

Business Case

There are three key components to a business case for a carbon project – carbon yield & revenue, start-up & ongoing costs, and co-benefits for production, resilience, biodiversity & marketing.

Carbon yield - The FullCAM model incorporates a spatial layer (Mbio) that represents the theoretical maximum biomass for any given location across Australia. This can be regarded as an index for carbon yield. The Mbio layer over Ridgeview is presented in the map below, showing a modelled gradual decrease in carbon yield from the south-west towards the north-east of the property until a line is reached about 500 m west of Yadena Creek where a step-change to a lower yield occurs (dark shaded area in north-east quadrant of property).

Ridgeview carbon yield index

The FullCAM model was run to estimate carbon yields for the various parts of the proposed Ridgeview planting. The parameters entered into the model assumed less than 75% of planted species to be trees (the rest being shrubs/understorey) and less than 1500 stems per hectare in total. The model outputs suggest that the fenceline shelterbelts in the lower yielding (NE) area will sequester carbon at a rate of 3.5 tCO_2e^-/ha/yr. The shelterbelts throughout the remainder of the property will yield carbon at the higher rate of 8.5 tCO_2e^-/ha/yr. For the block planting area, the estimated yield is 6 tCO_2e^-/ha/yr. On an area-weighted basis, the overall project would yield 7.16 tCO_2e^-/ha/yr. This equates to 1,432 tCO_2e^-/yr for the entire project area and **35,787 tCO2e-** for the entire 25-year crediting period.

ENVIRONMENTAL PLANTING PROJECT

The following business case example is based purely on estimations and indicative ACCU pricing. It is for demonstration purposes only and RegenCo recommends the landholders seek independent financial advice that is specific to their business at Ridgeview before deciding on any environmental initiative.

Business Case

Potential revenue - The estimated carbon yield can be converted to a gross revenue estimation, noting that the carbon market is still evolving and future value of ACCUs is unknown and hard to predict. At the time of writing, the ACCU spot price is $34.25. Environmental Planting projects may draw a premium due to their perceived higher integrity, though this not certain. Recent ACCU spot price history can be viewed here.

Therefore, to cover an indicative range of potential future ACCU values, we provide here a revenue estimation at $40/ACCU (approx. current value with an Environmental Planting premium), $50/ACCU (assuming future value gains), and $30/ACCU (assuming future value losses). The figures incorporate a mandatory 5% deduction of ACCUs issued by the regulator to cover the project's "risk of reversal buffer".

Est. Gross Revenue	$30/ACCU	$40/ACCU	$50/ACCU
Annual	$40,812	$54,416	$68,020
Total (25 yr)	$1,020,300	$1,360,400	$1,700,500

Carbon project implementation costs - Costs for carbon project implementation can be categorised into:

1) initial (start-up) or ongoing costs, and
2) operational (on-farm) or ACCU Scheme participation costs.

The table to the right presents a breakdown of potential estimated costs by generalised item, and potential estimated revenue projections assuming a $40/ACCU carbon credit value.

TOTAL COSTS and REVENUE over project lifetime	
ON-GROUND WORKS COSTS	**$414,380.00**
Fencing	$207,000.00
Tubestock planting	$67,650.00
Direct seeding	$79,730.00
Site maintenance	$60,000.00
ERF PARTICIPATION COSTS	**$165,000.00**
Feasibility assessment	$2,500.00
Registration	$2,500.00
Annual monitoring and reporting	$100,000.00
Auditing	$60,000.00
CARBON REVENUE	
Carbon revenue per ha per yr	**$272.08**
Carbon revenue per yr	**$54,416.00**
Total aggregated carbon revenue over 25 year crediting period	**$1,360,400.00**

And the following table presents some summary statistics describing the project's basic business case, (minus production system benefits) including a breakdown of potential costs over the first 5 years vs the last 20 years of the project.

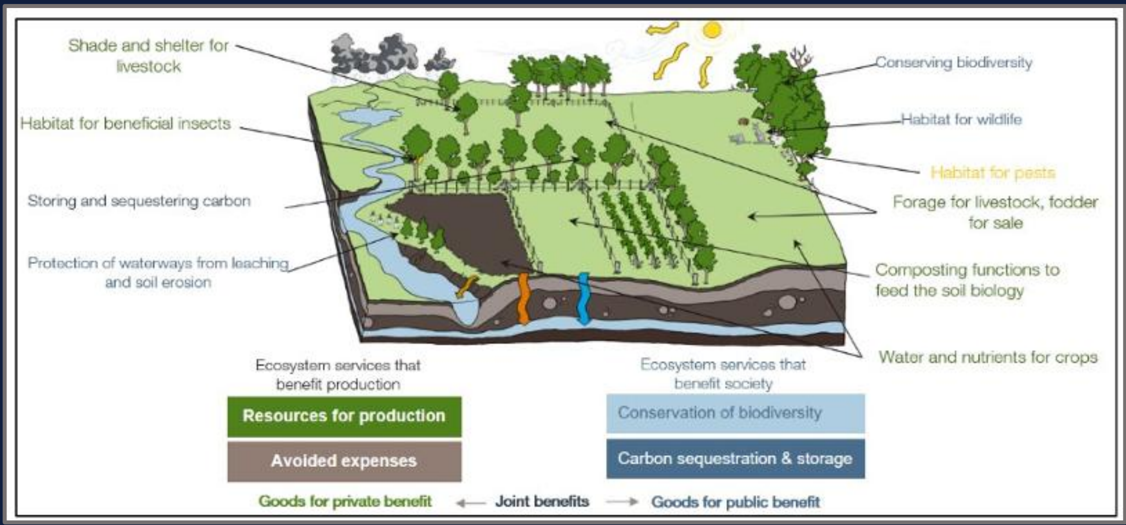
BUSINESS CASE SUMMARY STATISTICS	
Total cost	**$579,380.00**
Cost per ha	$2,896.90
Cost of production (per ton CO2e)	$16.18
Total cost in first 5 years	$479,340.000
Total cost in last 20 years	$99,980.00
Total profit (after all costs)	**$781,020.00**
Profit per ha	$3,905.10
Profit on production (per ton CO2e)	$21.82
Annualised profit over 25 years (after all costs)	$31,240.80
Annualised per ha profit over 25 years	$156.20

ENVIRONMENTAL PLANTING PROJECT

Business Case

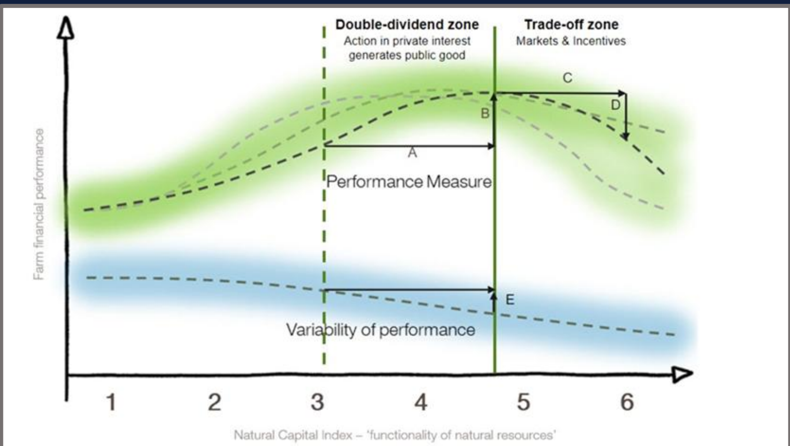
Production & Resilience - The system production and resilience co-benefits of the proposed Environmental Planting project are described in some detail in "*Section 3: Key Opportunities*" of this document. The information provided includes some financial estimates against practice change that the landholders could use to estimate potential financial benefit for their operation.

Farming for Future is a program focusing on private production benefits associated with on-farm natural capital, including remnant native vegetation, productive pasture and croplands, riparian areas, agroforestry, environmental plantings and animals.



The pilot program report (focusing on 113 farms, mainly sheep/wool, in the Central & Tablelands region, South-eastern Australia and South-western Australia) confirmed that potential benefits like increased productivity, profitability and resilience are the most compelling motivation for producers to invest in natural capital, and that natural capital is positively correlated with production efficiency, gross margin and earnings before interest and tax (EBIT).

- Our landholder surveys show that the potential for private financial benefits is the most compelling reason for producers to invest in natural capital improvements.
- Our analysis of 113 livestock farms indicated that natural capital is positively correlated with production efficiency across a number of our natural capital indices, providing evidence of a 'double dividend zone'.
- We found different benefit pathways through which natural capital can support farm businesses, including via improving productivity, and/or by reducing input costs. These are relevant to different extents in our different study regions.
- High natural capital farms also had lower input costs across certain of the cost types examined (energy, fodder, health and labour). We suggest that natural capital may support production efficiency by replacing / substituting for some of these inputs.
- Natural capital was positively correlated with financial performance (gross margin and EBIT). Optimised natural capital levels delivered higher EBIT with median $75 - $175 /ha/yr higher in the Central and Tablelands region, $20 - $135 /ha/yr higher in the South-eastern region, and ~$70 /ha/yr higher in the Western region, depending on the farm type. Differences in gross margin were of a similar magnitude.
- High natural capital was also associated with higher levels of resilience to both climate and market shocks. This may occur for two reasons. Natural capital may help build climate resilience by enabling higher levels of water retention in farm soils. It may help to build financial resilience and improve financial performance because natural capital inputs tend to be low-cost relative to manufactured inputs, and their 'price' is not subject to volatility of international market shocks or input supply chain disruptions.



Explanation for Figure 5: The Natural Capital Index (x axis) indicates increasing levels of natural capital functionality as the scale increases from left to right. The Y axis indicates farm financial performance, and may be measured as gross margin, EBIT, productivity or any other of a range of potential measures of financial performance (or other benefits like producer wellbeing). The two curves indicate potential associations between different 'levels' of natural capital and measures of performance (green shaded curve), and performance variability (blue shaded curve).

Importantly, the research also demonstrated that natural capital can confer livestock businesses with increased levels of resilience in the face of both climate and market shocks – delivering increased stability on EBIT for livestock operations from 2017 to 2022.

ENVIRONMENTAL PLANTING PROJECT

Business Case

Finance - The proposed project would deliver a significant proportion of the infrastructure requirements outlined in the current PMP for Ridgeview:

- All fence line shelterbelts identified in the PMP would be established (as a relatively small proportion of the total proposed planting area).
- All Priority 1, 2, 4 and 5, fencing as identified in the PMP, would be delivered, as well as some Priority 3 fencing. This fencing is estimated to cover off on two-thirds of the fencing planned under the PMP (about $100k delivered of $150 k planned).
- A further $100k+ of fencing would be delivered, mainly to double-fence shelterbelts, but also to facilitate an effective rotational grazing system.
- Potentially, some of the water management infrastructure identified in the PMP could be delivered as part of the Environmental Planting project on-ground works. For example, pipelines (currently budgeted at about $20k) might be laid to assist with establishment watering, as required.

The carbon revenue from the project potentially offers a pathway to pay for these costs, already planned under the PMP, either up-front or by servicing a bank loan, depending on the selected business model. If taking out a loan to pay for on-ground works, discounted interest rates (e.g. green loans) are available from some lenders. For example, Rabobank is currently offering discounts of up to 1.15% on loans for Environmental Planting carbon projects.

Nature Repair & Biodiversity Markets – Biodiversity markets operate by putting a price on nature commodities or ecosystem services, such as woodland bird communities, with the intention of facilitating investment in conservation and restoration. At this stage biodiversity markets are in their early days and it has not yet been well established what the scale of the market for these products might be, although financial advisory, PwC, estimates that a biodiversity market could be worth $137 billion by 2050.

Mechanisms are now emerging to enable land managers to earn high-integrity products representing scientifically robust verification of positive biodiversity outcomes. Accounting for Nature, for example, are developing two products, one that is linked to nature-positive carbon projects (CarbonPlus™), and one that generates tradeable certificates independent of any carbon value (NaturePlus™).

The baseline assessment performed on the woodland bird community has placed Ridgeview in a strong position to take advantage of these products and add further value to the carbon revenue earned through the planting project. The soil parameters that have been tested at Ridgeview could also enable a baseline to be established under one of AfN's soil methods - *S-02: Level 3 Soil Assessment for Productive Land (Landcare).* It should be noted that there would also be additional costs if participating in a scheme such as these (e.g. monitoring, reporting and auditing costs).

Another potential pathway is through the Australian Government's proposed Nature Repair Market. Under the scheme, which will work in alignment with the ACCU scheme, nature repair projects such as the proposed Environmental Planting project can generate a tradable certificate. Biodiversity certificates will describe the biodiversity benefits from each project in a consistent way. This information will help the market users to compare and value projects. The 2024 Environmental Planting Method acknowledges the development of the nature repair market, which means registering the carbon planting for nature repair credits can be considered, once this new market comes online.

In preparation for this new market, the Australian Government ran a Carbon + Biodiversity Pilot in 2022-23 across six Natural Resource Management regions, including Northern and Yorke. The project aimed to deliver income to landholders through carbon credits while testing aspects of buying and selling biodiversity services. Under this scheme, proposed projects were graded with a modelled biodiversity benefit score. Based on the score, a biodiversity payment was calculated to cover a portion of establishment costs. Business models such as these may be worth exploring with third parties, such as NRMs and environmental not-for-profit organisations.

ENVIRONMENTAL PLANTING PROJECT

Business Case

Market access – It is widely acknowledged that there has been a shift by large wholesalers of farm products, including lamb and sheep meat, towards requiring suppliers to show their credentials in being good stewards of the environment, reducing the carbon footprint of their production systems, and being attentive to animal husbandry and humane treatment.

For example, Thomas Foods International require their suppliers to be accredited under their Thomas Family Guarantee program. This includes environmental guidelines requiring suppliers to consider actions such as planting trees and other native vegetation to encourage biodiversity, fencing creeks to deter erosion, and reducing chemical application across crops and pastures. The proposed Environmental Planting project, amongst other actions under the PMP, would enable the landholders at Ridgeview to keep meeting requirements such as these to maintain market access and "stay ahead of the curve" of increasing demands on suppliers.

There are also programs in place and emerging from some large buyers of farm product that deliberately, as a marketing angle towards higher value product, look to raise the bar on "Nature Positive Farming". For example, Woolmark used the Farming for the Future pilot to help identify 12 core metrics for monitoring and reporting by suppliers, and awareness raising and capacity building by Woolmark to drive improvement of environmental performance.

Similarly, in order to maintain access to international markets, Sheep Producers Australia (SPA) and Wool Producers Australia (WPA) lead the Sheep Sustainability Framework. The Sheep Sustainability Framework monitors and measures industry performance against priorities aligned with four themes: animal care, the environment, economic resilience, and people and community. It is likely that reporting of performance against these themes will have the effect of raising industry expectations on suppliers over time.

Some farmers who are undertaking strong environmental stewardship actions on their farms and/or adopting more regenerative practices are leveraging the sustainable agriculture marketing angle to attract a premium price in "paddock-to-plate" business models. There is a growing product market for these kind of offerings, including in the lamb/sheep meat industry, in Australia. An example of a Mid North farm that has adopted this approach is Gilberdale farm, north of Gawler.

The above considerations around market access don't only relate to the proposed planting project but also to other matters identified in the PMP and discussed in this document, such as implementing a rotational grazing system, undertaking actions to conserve the permanent spring on Yadena Creek, and returning a diverse group of fodder shrubs to the grazing system.

A Landscape Function Toolkit (LiFT) being developed by the Mulloon Institute may soon offer a cost-effective and accessible framework for assessing, monitoring and reporting on landscape condition and resilience improvements made through management actions such as those proposed here and in the PMP.

Acknowledgement

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