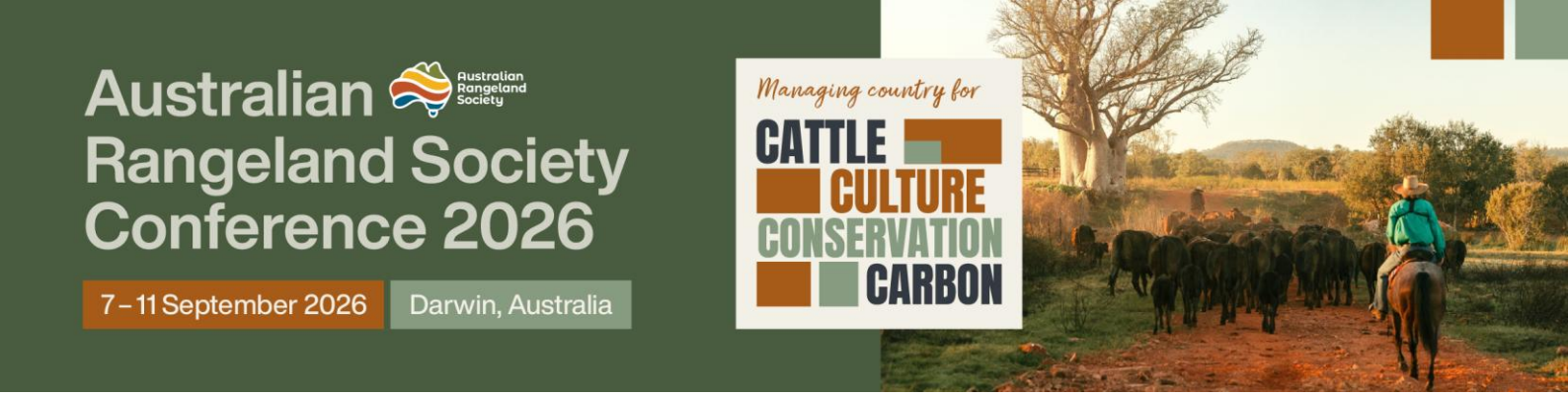


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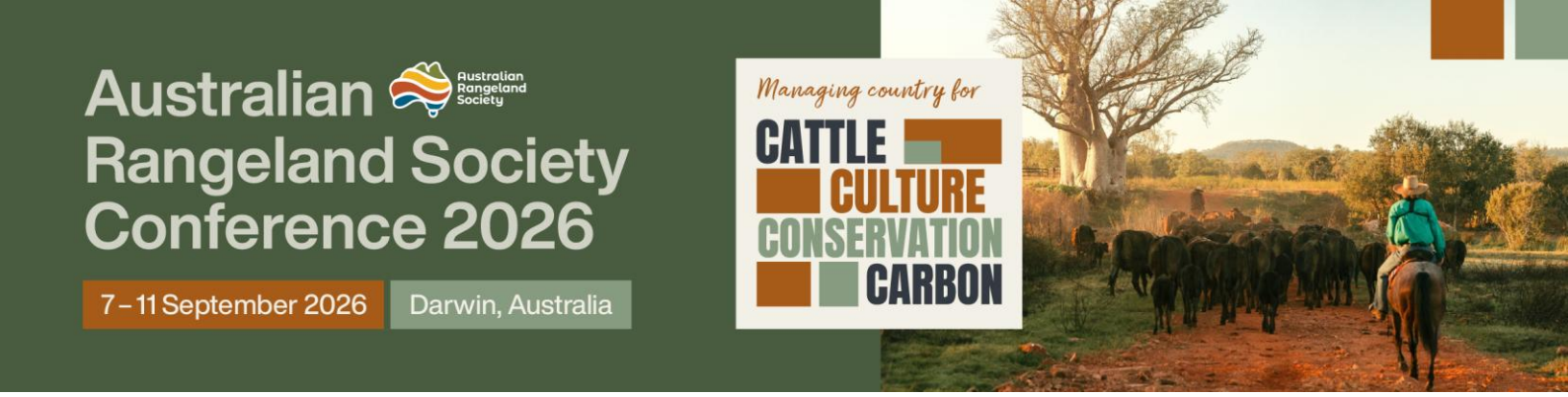
Darwin, Northern Territory

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Mānuka and cattle not quite the honey pot

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Abstract
Incorporating productive trees and shrubs into cleared grazing land offers a potential win:win: income from both livestock and tree-crop enterprises, alongside benefits for carbon, biodiversity and landscape function. However, proven silvo-pastoral options in the grazing lands of Australia are limited.

Leptospermum plantations to support high value 'Mānuka' honey production and livestock grazing are a potential opportunity. However, there is currently little demonstrated plantation success, particularly in more challenging climatic and edaphic regions.

We collaborated with an innovative grazing business in southern inland Queensland to implement a replicated trial, which was established in 2021 to assess five *Leptospermum* varieties and two plant spacings (1 and 2m), along with improved agronomic techniques. Shrub survival, growth and carbon sequestration were recorded for three years.

Despite the agronomic efforts and relatively favourable rainfall conditions, after three years, survival was >50% for only two varieties and shrub growth was slow (53-66cm average height for the best four varieties). Shrub height was substantially impacted by frost each winter. There was no impact of plant spacing, due to the small shrub size reached. Restricted sampling of nectar indicated that two varieties contained medium to high levels of the active ingredient hydroxyacetone (DHA). An indicative *Leptospermum* shrub height to above-ground carbon biomass relationship was developed for shrubs up to 2m high.

Based on our results, establishing a *Leptospermum* plantation in the southern inland Queensland region appears to have a low likelihood of success for delivering productivity, economic and environmental outcomes.

Introduction

Incorporating trees and shrubs (particularly native species) with productive benefits into cleared grazing land is a potential win:win with business income from livestock and tree-crop, and additional benefits for carbon, biodiversity and landscape function (Cubbage *et al.* 2012). However, silvo-pastoral or agroforestry options are limited or unproven for much of Australia's grazing lands, particularly regions with reasonably extreme climate (e.g. low rainfall, frost) or edaphic limitations. Demonstrated silvo-pastoral systems have had success in limited regions which grow; commercial timber species or forage shrubs (e.g., Leucaena). Although, even these relatively well-known productive systems are still receiving industry investment to enhance producer uptake (e.g. Queensland Pasture Resilience Project and Steak n Wood project).

Honey production from silvo-pastoral systems is potentially an option in Australia. *Leptospermum* plantations have been established in New Zealand to support high value 'Mānuka' honey production (Boffa Miskell Ltd, 2017). Mānuka honey contains Methylglyoxal (MGO) which has antibacterial and healing properties. MGO is naturally formed in honey from Dihydroxyacetone (DHA) in the nectar of *Leptospermum* species, although the level of DHA varies considerably between *Leptospermum* varieties (Cokcetin, *et al.* 2016). Native *Leptospermum* species have a wide geographic range in Australia, raising the possibility of successful establishment and survival of *Leptospermum* plantations for honey production.

An innovative producer in southern inland Queensland trialled a *Leptospermum* plantation in 2018 which largely failed to establish, during one of the most severe droughts on record in the years following

planting. Apart from prolonged dry periods, the region also experiences severe frosts and is relatively infertile.

To better inform future investment, a replicated experiment was established in 2021 to assess five *Leptospermum* varieties and two plant spacings (1 and 2m), using improved agronomy practices with soil ripping and cultivation, fallowing, pre-and post-emergent herbicide application, mulching and use of irrigation drippers. Survival, growth and carbon sequestration were recorded for three years.

Methods

An experiment was established in southern Queensland, 27km SE of Texas (-29.00, 151.39), on undulating rocky soil, typical of the region. The region also experiences severe winter frosts. The trial assessed five *Leptospermum* varieties (Table 1) and two intra-row plant spacing treatments (1 and 2m between plants) with three blocks (reps). Each plot contained 35 seedlings. Rows were 3.5m apart, with plots either 35m or 70m long depending on plant spacing. Blocks were arranged down the slope.

Rows were sprayed with glyphosate 3m wide to allow fallowing for soil water storage, the planting row was ripped and cultivated about 1m wide, an irrigation line with a dripper for each seedling was installed. Prior to planting, pre-emergent herbicide Trimac (active ingredients 880g/kg *Terbacil* + 40g/kg *Sulfometuron Methyl)* was applied and a single tyne cultivation was used to loosen soil down the centre of row. Sugar cane mulch was placed around seedlings; ~30cm radius. Seedlings were planted 4 May 2021.

Five potentially adapted and high DHA active ingredient *Leptospermum* varieties were selected for the trial (recommended by Grand Ridge Propagation Nursery) (Table 1). 210 seedlings of each type were planted (total 1050 seedlings).

Table 1. *Leptospermum* varieties, experimental code name, indicative flowering time and measured nectar dihydroxyacetone (DHA) content.

***Leptospermum* type**	**Experimental code name**	**Flowering time**	**DHA content (ppm)**
L. polygalifolium spp tropicum (Cardwell)	Card	Early	4315
L. polygalifolium spp polygalifolium	Poly	Mid	14564
L. brachyandrum	Brachy	Late	
L. petersonii	Peter	Late	
L. whitei	Whit	Mid	

The plots were sampled 7 times between May 2021 and July 2024. Measurements included, count of live seedlings in each plot, shrub height and canopy diameter of 10 random live seedlings per plot, if >10 were still live.

Nectar of 4 plants were sampled from *L. polygalifolium* spp tropicum (Cardwell) and *L. polygalifolium* spp. polygalifolium and analysed for the active ingredient dihydroxyacetone (DHA) by the University of the Sunshine Coast.

A shrub height to above-ground carbon biomass relationship for the *Leptospermum spp.* shrubs was developed by harvesting 15 shrubs from 'spare' seedlings planted at end of plot rows and from the original landholder planting. Harvested plants were dried at 60^0C and weighed. Carbon content was assumed to be 50%.

Due to small plant size, no grazing occurred during the trial.

Results

Climatic conditions following planting included a relatively wet winter with multiple severe frosts. The pre-emergent herbicide was effective and minimised weeds until the following summer. Twelve months

after planting, seedling survival was reasonably good ranging from 73 to 98% across varieties, indicating reasonable establishment agronomy. However, many plants had reshot from near the base of the plant after frosting of the main stem, with *L. petersonii* the most affected. Over the following two years, survival declined further to range from 7% for *L. petersonii* to 70% for *L. polygalifolium* spp polygalifolium after three years (Fig. 1a). Survival was likely impacted frosts and weed competition.

Shrub growth overall was slow, with plants often declining in height following frost each winter. After 3 years, average height of live shrubs ranged from 11cm for *L. petersonii* to 66cm for *L. polygalifolium* spp tropicum (Cardwell), with *L. brachyandrum*, *L. polygalifolium* spp polygalifolium and *L. whitei* similar at 53-57cm (Fig. 1b).

Nectar from *L. polygalifolium* spp polygalifolium flowers contained high levels of dihydroxyacetone (DHA); 14564 ppm DHA, with *L. polygalifolium* spp tropicum (Cardwell) classed as medium; 4315 ppm DHA (Table 1). Bee foraging activity was observed on shrubs that flowered during the trial (Fig. 2a).

An indicative *Leptospermum* shrub height to above-ground carbon biomass relationship was developed for shrubs up to 2m high (Fig. 2b).

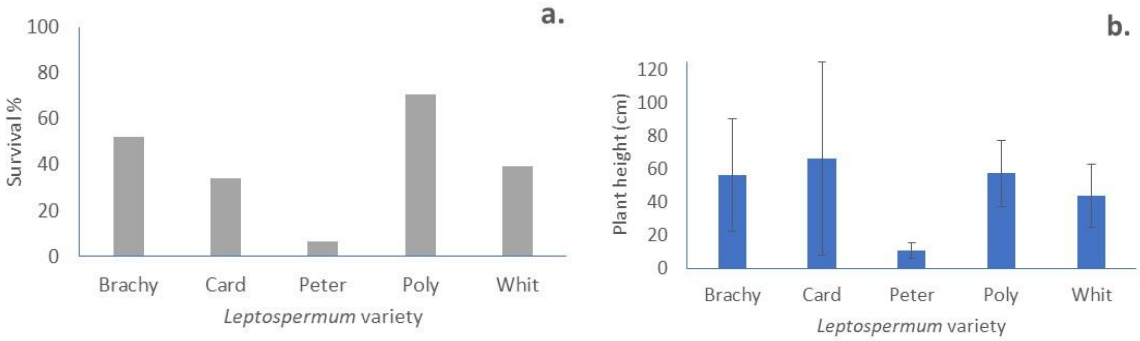


Figure 1. *Leptospermum* variety survival after three years (a.); *Leptospermum* variety average plant height (cm) of live shrubs after three years (b.). Error bars are standard deviation.

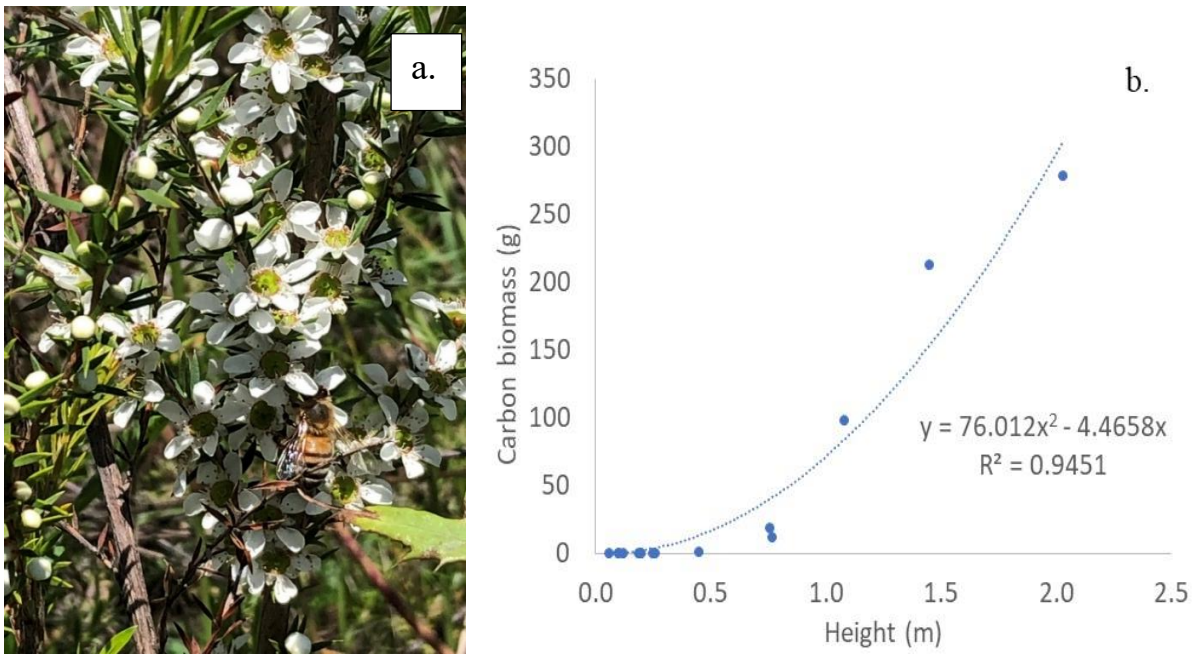


Figure 2. *Leptospermum* flowers and a foraging bee (a.), and relationship between *Leptospermum* shrub height and above-ground carbon biomass (b.).

Discussion

Silvo-pastoral system options which incorporate trees and shrubs into grazing land with production benefits from livestock and tree-crop have potential for triple bottom-line benefits (social, environmental, and financial). Social and environmental benefits include: carbon, biodiversity, landscape function, animal welfare and aesthetics. However, proven silvo-pastoral options particularly in regions with challenging climatic (e.g. low rainfall and frost) and edaphic (infertile or low water holding capacity) traits are limited.

We collaborated with an innovative producer to trial establishing a *Leptospermum* plantation using 'good' agronomic techniques and five likely adapted *Leptospermum* varieties. After three years, shrub survival and growth were relatively poor. Combined with the significant investment in planting and early management of the plantation, establishing a *Leptospermum* plantation in the southern inland Queensland region appears to have a low likelihood of success for delivering productivity, economic and environmental outcomes. Frost impacting small plants before reaching a more frost-tolerant size was a key constraint in this trial.

On the positive side, flower nectar of two varieties did contain medium to high levels of the active ingredient dihydroxyacetone (DHA), bee activity was observed and the shrubs have potential to store carbon in biomass.

If further investment in *Leptospermum* plantations was progressed in the southern inland Queensland, key considerations to enhance shrub survival and growth should include:

- Selecting more favourable regions, landscape position and land type (low frost, reasonable rainfall or effective irrigation, more fertile soil).
- Optimised soil nutrition (consider fertiliser).
- Improved post-planting weed control particularly in year two and three following dissipation of the pre-emergent herbicide.
- If a plantation was successfully established, the grazing component of a silvo-pastoral system still requires testing.

Although the trialled *Leptospermum* plantation silvo-pastoral system was not a success. It is recommended that other silvo-pastoral systems are trialled and tested to provide options for producers to enhance productivity, carbon and biodiversity benefits.

Acknowledgements

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