234

Multipurpose shrub and tree legumes for Northern Australian rangelands

Gardiner, C[1]; Kempe, N[2]; O'Reagain, J[3]

[1] Veterinary Sciences, College of Science & Engineering, James Cook University
christopher.gardiner@jcu.edu.au

[2] Agrimix Pty., nick.kempe@agrimix.com.au

[3] Veterinary Sciences, College of Science & Engineering, James Cook University,
joe.oreagain@jcu.edu.au

Key words: Ecosystem services, shade, shelter, Mitchell Grass Downs

Abstract
The vast open rangelands of Australia's Mitchell Grass Downs Bioregion as depicted in Figure 1 are a significant producer of livestock and the region is dominated by the *Astrebla* grass species. Multipurpose shrub and tree legumes could play an important role in providing many ecosystem services such as drought fodder, shade, shelter, N fixation, carbon sequestration, biodiversity, habitat, and they may also potentially contain novel compounds that could have useful phenolic and or antioxidant, anti-methanogenic properties which could benefit animal production and the environment.

As part of CRC P 58599 project "Legumes for the north" the seeds of a range of native and exotic shrub and tree legumes were sourced from across North Queensland, grown as tube stock and then transplanted at five sites across the region to evaluate their adaptability to the region. The mix of species included fast and slow growing, long lived and short-lived perennials including species of *Acacia, Adenanthera, Albizia, Bauhinia Cajanus, Gliricidia, Peltophorum, Pongama, Sesbania, and Vachellia.* Most of these species were planted at each site on vertosol soils in semi-arid locations with mean annual rainfall from 400mm to 580mm, and irregularly watered by artisan bore water until well established.

After three years of growth, initial observation of the establishment phase and persistence indicates that several species across the sites show agronomic promise including but not limited: *Albizia lebbeck, Gliricidia sepium, Peltophorum pterocarpum.* Several species failed to persist or have had poor growth at least at some sites including *Cajanus cajun*, *Sesbania sesban* and *Adenanthera pavonina*.

It is envisaged that the successful species could be planted as mixed species plantings on the open treeless grasslands radiating out along fence lines from existing bores/farm dams with simple trickle irrigation likely to be essential for at least the establishment phase. Once established the shrubs and trees would provide many of the ecosystem services outlined above.

Introduction

Shrubs and trees have long been considered important for the nutrition of grazing and browsing animals in Australia, particularly in the north where the quantity and quality of pastures is poor for long periods. Over 70% of Australia falls within the arid and semi-arid climatic zones where extensive grazing of livestock is the dominant land use (Lefroy *et al* 1992.) This includes the vast open, mainly treeless (Fig 1) rangelands of the Mitchell Grass Downs Bioregion which are dominated by the *Astrebla* grass species. The climate of the region is severe as is the edaphic environment with vertosol soils. These rangelands are dominated by C4 grasses noted for their resilience but are of poor nutritive value and decline in quality with maturity (Minson 1981). Lowry *et al* (1993) suggest that the introduction of legumes may increase production not only through an increase in total edible dry matter but by acting as a supplement to promote the utilisation of the lower quality diet. To date, the introduction of sown legumes has proved difficult, with few, if any, being successful (Gardiner 2016). However, adapted and resilient shrubs and trees may be an option and could potentially contribute to nutrition and other facets of animal production. During drought, top feed/browse species become of important (Chippendale and Jephcott 1963, Everist 1985). These authors and Newton (1970) and Guttridge and Shelton (1994) list many native and introduced shrub and tree species as having potential in northern grazing systems including *Acacia, Albizia, Bauhinia, Capparis, Desmanthus, Eucalyptus, Gliricidia, Geijera, Leucaena, Owenia, Sesbania* and *Vachellia* among others. Dynes and Schlink (2002) however note that investigations of the potential of native shrubs and trees (particularly *Acacias*) as fodder sources for livestock in Australia have been limited to the more widespread better-known species such as Mulga (*Acacia aneura*).

There are few shade trees in the region and temperatures are high, with mean maximum temperatures exceeding 35ºC for many months per year. For example, Camooweal in Western Queensland has on average 155 days per year with temperatures >35ºC, and 37 days per year >40ºC (BOM 2024, McCosker 2023). The importance of heat stress in limiting potential animal production in NW Australia was noted by Petty (1997, and lack of shade can be detrimental to survival of newborn calves and lambs (Schmidt 1969 cited by Orr and Holmes 1984). Tunkala *et al* (2023) studied the *in vitro* characteristics of several of the aforementioned species and found that *Gliricidia* and *Vachellia* have a slowly degradable protein content while *Bauhinia* emerged as a candidate to assist protein protection in the rumen and reduce methane emissions.

Multipurpose shrub and tree species could play a role in providing many ecosystem services such as drought fodder, shade, shelter, N fixation, Carbon sequestration, biodiversity, habitat, and they may potentially contain novel compounds with useful phenolic, antioxidant and/or anti-methanogenic properties of benefit to animal production and the environment.

This study set out to screen several well adapted shrubs and tree species that may then progress to (if not already) domestication and planting out as multipurpose species (Figure 1). These mixed shrub and tree plantings (including tall, short, fast growing, slow growing, palatable, not palatable species) would radiate out along fence lines from existing bores and farm dams or to nearby shelterbelts or groves with low-cost trickle irrigation to aid establishment.

Fig 1. A schematic concept diagram of before and after planting multipurpose species on the near treeless Open Mitchell Grass Downs utilizing existing bores and fence lines.

Fig 2. A) The location of the shrub/tree evaluation sites and mean annual rainfall of the sites. B) Aerial view of the layout and surviving species at the Hughenden trial site as of October 2024.

Methods

As part of CRC P 58599 project "Legumes for the north" and during COVID 19 pandemic period,(limiting travel and access to the remote sites) in 2020 seeds of a range of native and exotic shrub and tree legumes were sourced from across North Queensland. They were selected based on availability of seed and desirable traits such as drought tolerance, fodder production, edaphic adaptability, grown as tube stock in a commercial nursery and then transplanted to five sites across the region in mid-2021 (Figure 2). The aim was to evaluate the adaptability of the species to the region. The mix of species included fast and slow growing, long lived and short-lived species *Acacia auriculiformis, A.holosericea, Adenanthera pavonina, Albizia lebbeck, Bauhinia hookeri, Cajanus cajun, Gliricidia sepium, Peltophorum pterocarpum, Pongamia pinnata, Sesbania sesban,* and *Vachellia sutherlandii.* These species were planted at each of the five sites, except for *V. sutherlandii* (due to scarcity of seed) on vertosol soils in semiarid locations with mean annual rainfall ranging from 400mm to 580mm (Fig. 2). Plants where at least initially watered via a trickle irrigation system with water sourced from artesian bores/dams. The frequency of

watering and maintenance of the plots varied across the sites. Infrequent watering occurred until the plants were well established. Where available, 13 seedlings of each species were planted 2m apart within rows with 4m between rows. The plots were inspected occasionally, with reports and images from station managers collated. Data presented here are for the Hughenden site only but reflect observed results across the region. At the Hughenden site data were collected on plant survival, height, diameter at breast height (DBH), and the general status of the plants was recorded in October 2024.

Results

After three years growth, initial observation of the shrub and tree establishment phase and persistence indicated that several species showed agronomic promise across the sites including: the *Acacia* species*, Albizia lebbeck, Bauhinia* hookeri*, Gliricidia sepium, Peltophorum pterocarpum* and *Pongamia pinnata.* Survival and growth (some to >4m tall, Table 1) varied across sites, with several short-lived species such as *Cajanus cajun and Sesbania sesban* displaying rapid initial growth and then tended to die at most sites. *Adenanthera pavonina* performed poorly at all sites.

Table 1. Shrub/treegrowth data from Peronne Station (Hughenden, NW Queensland) October 2024

Species	% survival	Mean DBH (cm)	Mean Height (cm)	Notes * = native
Acacia auriculiformis*	69	5.2	317	Dense foliage
A.holosericea*	23	4.4	438	Survivors are robust
Adenanthera pavonina*	15	N/A	100	Poorly adapted
Albizia lebbeck*	100	2.6	335	Leafy, good canopy, well grown
Bauhinia hookeri*	77	2.5	114	Slow growth but good survival
Cajanus cajun	0	0	0	Short lived species, initially good
Gliricidia sepium	100	4.84	302	Leafy, multi branched, thriving
Peltophorum pterocarpum*	100	6.7	177.6	Leafy, thriving
Pongama pinnata*	84	1.46	164	Slow growth but good survival
Sesbania sesban	0	0	0	Initially good, but short-lived
Vachellia sutherlandii*	50	1.6	252.5	Limited seed for planting

A video overview of the concept of multipurpose shrub and trees for the open downs, the Hughenden site and various species is available at: https://www.youtube.com/watch?v=VGvAVjgX7FU

Discussion and conclusions

Albizia, Gliricidia and *Peltophorum* have been particularly successful to date at all sites, with 100% survival and good growth at the Hughenden site. The *A. auriculiformis, Bauhinia, Pongamia,* and *Vachellia* species are promising. The short-lived species such as *Cajanus* and *Sesbania* can potentially provide good quick fodder, habitat, and cover while other species establish, but generally failed to persist, although at other unrelated locations they have been noted to recruit from seed. There are many other species (including non-legumes) that should be investigated, for example Everist (1986), with local native ecotypes most likely to be successful and having some

social licence in the community. It is envisaged that the successful species could be planted as mixed species plantings on the open treeless grasslands radiating out along fence lines or in shelterbelts or groves from existing bores/dams with simple trickle irrigation which is likely to be essential for at least the establishment phase. On-going long-term monitoring of these plots is required to evaluate among other attributes their response to lopping/grazing, shade, nutritional value. Further research is also essential to select and evaluate other adapted and appropriate species, develop suitable agronomic and management practices for the establishment, longevity and utilisation of the species, and evaluate the costs and value of both shrubs and trees to livestock production, animal welfare and the environment. Once established these multipurpose shrub and tree species could potentially provide many of the ecosystem services outlined above benefiting the environment, animal welfare and production.

Acknowledgements

The ongoing care of the tree plots by the various station managers and staff is much appreciated as is the contribution of Agrimix staff, JCU, and the CRC P 58599 project for funding. Thanks to Jirapun Kota for assistance with field data collection.

References

BOM (2024) Camooweal. http://www.bom.gov.au/climate/averages/tables/cw_037010.shtml accessed 27/7/2024.

Chippendale G and Jephcott B (1963) Topfeed. The fodder trees and shrubs of Central Australia. NT administration Animal Industry Branch. Extension article 5.

Dynes R and Schlink A (2002) Livestock potential of Australian species of *Acacia. Conservation Science W. Australia.* **4** (3): 117-124.

Everist S (1986) Use of fodder trees and shrubs. Queensland Department of Primary Industries.Q185015.

Gardiner CP (2016) Developing and commercializing new pasture legumes for clay soils in the semiarid rangelands of northern Australia: The new Desmanthus cultivars JCU 1-5 and the Progardes story. In (Lazier JR and Ahmad N eds) Tropical Forage Legumes. CABI 2016.

Guttridge and Shelton (1994) Forage tree legumes in tropical agriculture. CAB. UK.

Lefroy E, Dann P, Wildin J, Wesley-Smith R and McGowan A (1992) Trees and shrubs as a source of fodder in Australia. *Agroforestry Systems* **20**, 117-139.

Lowry B, Schlink A and Carter J (1993) Nutritional value of *Acacia nilotica* subsp *indica* for sheep Mitchell Grass pasture. Final report. Project No.CSIO8P Australian Wool Research & Development Corporation. CSIRO.

McCosker K (2023) Reducing calf loss from exposure. Final Report B.GBP.0031. MLA.

Miller E (1996) A property level economic assessment of Prickly acacia (*Acacia nilotica*) on the Mitchell grass downs of Queensland. Proceedings of the X! Australian weed conference.

Minson DJ (1981) Nutritional differences between tropical and temperate pastures. In 'Grazing Animals. World Animal Science' (Ed: GHW Morley). pp143-157. (Elsevier Scientific Publishing Company Amsterdam, Netherlands).

Newton G (1970) Shading the Barkly. Turnoff. **2**, (4): 11-13. NT Dept. Agriculture & Fisheries.

Orr D and Holmes W (1984) Mitchell grasslands, In: Management of Australia's rangelands, (Ed: G. Harrington, A Wilson and M. Young) Chapter 16 pp241-254. CSIRO publications.

Petty SR (1997) Factors influencing the liveweight gain of cattle grazing irrigated leucaena-pangola pastures in NW Australia. PhD Thesis, Department of Agriculture, The University of Queensland https://doi.org/10.14264/46f8470

Sullivan ML, Cawdell AJ, Mader T, and Gaughan JB (2011) Effect of shade areas on performance and welfare of short-fed feedlot cattle. *Animal Science.* **89**, 2911-2925.