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Legume establishment in challenging environments of northwest Queensland

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Abstract

Establishing legumes on Mitchell Grass Downs country in northwest Queensland has the potential to reduce seasonal nutritional deficiencies, and subsequently increase animal performance within beef production systems. Legumes present an opportunity to increase crude protein (14 to18%) and metabolizable energy (8 to10 MJ/ME/kg DM) in the diet, as the nutritional quality of grass dominant native pastures declines markedly during the dry season (May to October).

Recent research initiated by the Queensland Government, with support from the Australian Government and Meat and Livestock Australia (MLA), has trialled establishment of deep-rooted and productive legumes (*Desmanthus, Stylosanthes*) on a property 80 km northeast of Julia Creek, Queensland.

This site is characterised by naturally treeless cracking clay soils, highly variable summer-dominant rainfall, (550 mm average annual rainfall, CV=0.43) and is highly susceptible to drought. The soil contains adequate Colwell phosphorus levels for legume growth (12mg/kg), however, sulphur (MCP) is low (4.6mg/kg). Rainfall variability, highly competitive adapted annual grass species and high summer temperatures (average maximum of 38^{o}C) make establishment of legumes difficult.

In January 2024, following 350mm of rain, uncoated *Stylosanthes seabrana* (Caatinga stylo, Primar) and scarified *Desmanthus* (Ray and Progardes) was broadcast onto cultivated strips (10 m wide) prior to further anticipated rainfall. No herbicide or fertiliser was applied. Assessment in March 2024 showed good seedling populations of desmanthus (~20/m^2) with fewer Caatinga stylo (~5/ m^2). In May 2024, the survival of seedling populations under a dense monoculture of Flinders grass (*Iseilema spp.)* was observed. Further measurements will be completed following the 2024/2025 wet season to confirm successful establishment of mature *Desmanthus* and *Stylosanthes* on this site. This research was initiated due to regional producer interest and will be utilised in extension efforts under the north Queensland Pasture Resilience Program (https://futurebeef.com.au/resources/qprp/).

Introduction

Queensland's beef cattle industry is the largest across all Australian states, with 10.7 million head (49% of the national herd) being recorded in Queensland (MLA 2022). The Northern Mitchell Grass Downs country in northwest Queensland has a semi-arid climate, with summer dominant rainfall typically from November to April. Wet season rainfall is reliant on the monsoon trough, and this is followed by a consistent and extended dry period from May to October. During this dry period, the quality of native perennial pastures, Mitchell grass (*Astrebla* spp.*)* and the highly competitive annual grass species Flinders grass (*Iseilema* spp.*),* declines significantly. This decline results in a nutritional deficit for beef cattle production, one of the area's main industries.

The production systems in the Northern Downs are predominantly extensive beef cattle grazing businesses on 'unimproved' rangelands native pastures (Chilcott, 2020). Desmanthus (*Desmanthus* spp.) and Caatinga stylos (*Stylosanthes seabrana*) are potentially useful legumes for the region due to their persistence on heavy clay soils in low rainfall environments under grazing, and high levels of seed production enabling them to recruit new plants for long-term pastures (Hall, 2005, Peck, 2012). Introducing legumes into the grazing environment provides an additional, readily-digestible feed source containing improved crude protein (14 to18%) and metabolizable energy (8 to10 MJ/ME/kg DM), mitigating the dry season nutritional shortfall. Compared to grass-only pastures, legume-grass pastures allow cattle to select a diet of higher quality and digestibility, often leading to increased intakes and improved animal production (live weight gain, reproduction) (Gardiner, 2016). Long term stocking rates for land in good condition vary from 10 to 15 ha for an Adult Equivalent animal (450 kg steer).

Northwest Queensland is considered a challenging environment for legume establishment due to its low annual average rainfall (550mm), high rainfall variability (CV=0.43), high summer temperatures (average maximum of 38ºC) and susceptibility to drought (Chilcott, 2020). Treeless cracking clay soils that are common in this area experience surface crusting that challenges seedling emergence if there has been rain after sowing and before seed germination. Soil phosphorus fertility is generally adequate for legume growth (Colwell 12mg/kg); however, sulphur is low (MCP 4.6mg/kg). Although responses to applied P and S are likely, application of fertiliser on extensive areas is costly and overall is not considered a viable option for legume pastures in this region.

Establishment of suitable legume strips into existing Mitchell and Flinders grass pastures has the potential to help to lessen the seasonal protein and energy shortages for grazing animals and support improved animal weight gain and production. The deep tap root of these legumes supports the production of green leaf well into autumn and winter. Additional benefits expected from introduction of legumes also include increased access to high quality forage, increased nitrogen fixation in the soil and thus improved soil fertility.

In response to regional grazier interest into methods to effectively establish pasture legumes in the region, a small on-property demonstration was developed by Queensland's Department of Primary Industries with support from the Australian Government and Meat and Livestock Australia. This site will be utilised under the Queensland Pasture Resilience Program to demonstrate feasible options for establishing legumes in northwest Queensland under challenging environmental conditions.

Methods

Following 350mm of rain and prior to further anticipated rainfall, a 10-ha unfenced site within a larger paddock was directly sown into 6m x 1000m strips. Caatinga stylo (Primar) and desmanthus (Ray and Progardes*)* were tested for germination performance (8/16 hours, 20/35° Dark/Light) and treated for hard seed dormancy by mechanically scarifying seeds prior to planting. The site had previously contained dense Flinders grass that had been baled to reduced existing dry matter. Sowing rates were adjusted to account for low germination percentage (hardseed content) and are presented in Table 1. No herbicide was applied.

No fertiliser was applied to best replicate typical extensive beef production systems in the region and to determine viable options for legume establishment in existing soil conditions. The seed was oversown into the cultivated strips using a fertiliser spreader. Rainfall on the site (30mm) shortly after planting prohibited planned rolling from occurring. A further 130 mm of rainfall was recorded from planting until the first assessment. At the first assessment in March 2024, seedling populations were recorded based on frequencies per m^2. Observations in May 2024 confirmed seedling survival. Further population counts, and pasture yields will be taken at the end of the 2024/2025 wet season.

Table 1. Legume species and adjusted sowing rates used in the legume establishment trial

Species	Variety	Recommended sowing rate (kg/ha)	Acceptable germination %	Germination test %	Adjusted sowing rate (kg/ha)
Desmanthus	Ray and Progardes	2 kg/ha	70%	60%	2.3 kg/ha
Caatinga stylo	Primar	2 kg/ha	70%	40%	3.5kg/ha

Results and Discussion

Initial seedling establishment was successful for Desmanthus populations (~20/m^2), but fewer Caatinga stylo plants (~5/ m^2) were recorded in the trial strips. The seedlings were small (estimated 3 to10 cm in height) however, and under a dense monoculture of Flinders grass. Most of the seedlings survived until May when the Flinders grass began to senescence but would undoubtedly have suffered from competition for light and nutrients. The rapid establishment of Flinders grass seedings needs to be considered when using cultivated strip systems. Potential options could be staggered cultivations to kill Flinders grass seedlings before sowing, either by repeated cultivation or application of a suitable herbicide before or immediately after sowing, or the use of selective herbicides to control the grasses post-emergence.

Despite the competition from the Flinders grass, this small strip trial indicates potential for simple approaches to desmanthus and Caatinga stylo planting and establishment into northwest Queensland Mitchell Grass Downs pastures. If further yield measurements confirm successful establishment, it may pave the way for successful adoption of legumes into these environments, with a range of associated benefits for pasture quality, soil improvement and animal performance.

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