final report

Project code: B.PRS.9011

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Date published: March 2012

ISBN: 9781741919523

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Fertility rundown in buffel pastures using legumes

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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Background

Pasture rundown has become a wide-spread phenomenon in the Maranoa region of Queensland negatively affecting the natural resource assets of landholders and reducing the carrying capacities of their pasture lands. It has been ascertained that the most feasible way to address the issue of 'nitrogen tie-up' in Buffel grass *(Cenchrus ciliaris)* dominated pastures is to establish legume species into the pasture sward to supply the necessary amounts of soil nitrogen required to support a active healthy Buffel grass pasture system.

The Maranoa region is traditionally one of the most productive beef cattle regions of Queensland and as a consequent little scientific research into the area of pasture improvement was considered necessary in the past by government agencies or agribusinesses. Buffel grass was widely sown into the fertile clay soils and for thirty to forty years was highly productive and resilient to drought and continuous grazing. More recently though, as soil nitrogen levels have fallen down to critical levels 'run-down' has become a fast growing land management problem as carrying capacities continue to decline whilst production costs increase.

The Maranao region experiences a wide variation in climatic conditions that vary from hot, dry summers to humid, wet summers and cool, dry winters to cold wet, winters. Soils, although of a clay texture, often have a shallow topsoil horizon lying above a highly sodic sub-soil. Deeper more fertile soils are often run-down due to a history of cropping (winter wheat production). Below is a table summarizing the land and soil features of the properties where the trial sites are located.

Property Name	Land Types	Soil Type(s)	Soil Constraints	Historical Land use	Current Land use	Carrying Capacity ha/AE
'Lenroy'	Box / sandal wood	Duplex red clays.	Strongly sodic sub-soils. Structural & nutrient decline due to cropping.	Winter cropping & grazing of native & naturalised pastures.	Grazing of old cultivation returned to sown Buffel pastures.	6
'Catherinvale'	Box / sandal wood	Duplex red clays.	Strongly sodic sub-soils. Structural &	Winter fodder (oats) cropping &	Grazing of native & naturalised pastures.	6

			nutrient decline due to cropping.	grazing of native & naturalised pastures.		
'Blue Hills'	Brigalow uplands	Loamy clay.	Strongly sodic sub-soils. Structural & nutrient decline due to cropping.	Winter cropping (wheat) & grazing of native & naturalised pastures.	Grazing of sown, native & naturalised pastures.	2-4

FIGURE 1 - A summary of landscape characteristics. *(Land Resource Areas, Roma District, QLD DPI 1983).*

From 1999 until January 2010 the Maranoa region experienced an extended dry period that resulted in a 'declared' drought. The Donnybrook PIRD legume trail was initially held up and an extension required as soil moisture levels were too low to warrant sowing seed between 2007 and 2009. When it commenced to rain in January 2010 land preparation was commenced and the sowing of summer legumes completed. The region has since experienced three (3) consecutive summer seasons with above average rainfall including three (3) flooding events. Although good summer growing conditions have resulted the extreme weather conditions, notably water-logging of soils in the summers of 2010 and 2011, have negatively affected germination rates of the summer legume seed planted. Although germination rates of the initial seed planted were low, germination from 'set seed' has been very good resulting in the establishment of significant legume populations.

Project Objectives

The objective of the Donnybrook Producer Initiated Research Development Legume Trail was to identify from available introduced legume species –

1) Legume species that can be established into existing pastures of the Maranoa that are dominated by the highly competitive introduced grass species Buffel grass *(Cenchrus ciliaris)*.
2) Legume species that are adapted to the landscapes, soil types and climatic conditions of the Maranoa region and have the ability to persist over time.
3) Legume species that have the potential to fix adequate amounts of soil nitrogen in order to reverse Buffel grass 'rundown' and increase existing productivity levels by –
    - Increasing the ground cover percentages to 70%.
    - Increasing carrying capacities from 1hd/6ha to 1hd/5ha.

4) Legume species that may have the potential to naturalise and colonise adjacent pasture areas.
5) The nutritional requirements of pasture legumes in relation to phosphorus, sulphur and calcium requirements.

Methodology

"The Donnybrook MLA PIRD Project aims to look at the potential role of legumes in overcoming 'nitrogen run-down' in Buffel grass pastures. Both winter and summer-growing legumes have been successfully established and are being evaluated. Summer growing or tropical legumes generally have a lower fertility demand than winter-growing or temperate legumes. Whilst they need adequate amounts of all nutrients, phosphorus and sulphur tend to be the key nutrients for legume growth. For the winter-growing medics we are looking for soil P levels (Colwell or Bicarbonate extraction method) of 25+ mg/kg (= ppm) whereas with the summer-growing legumes like Desmanthus and Caatinga stylo we are looking for soil P levels above about 15 mg/kg. In terms of the recommendations, there is also a stepwise approach to the rates for the temperate legumes, but more of a 'single cut-off point approach' for tropical legumes. With sown grasses you can probably get away with soil P levels of 12-15 ppm, depending on species". *(Dr Sid Cook, Grazing Lands Manager, Queensland Murray Darling Committee, Toowoomba Queensland).*

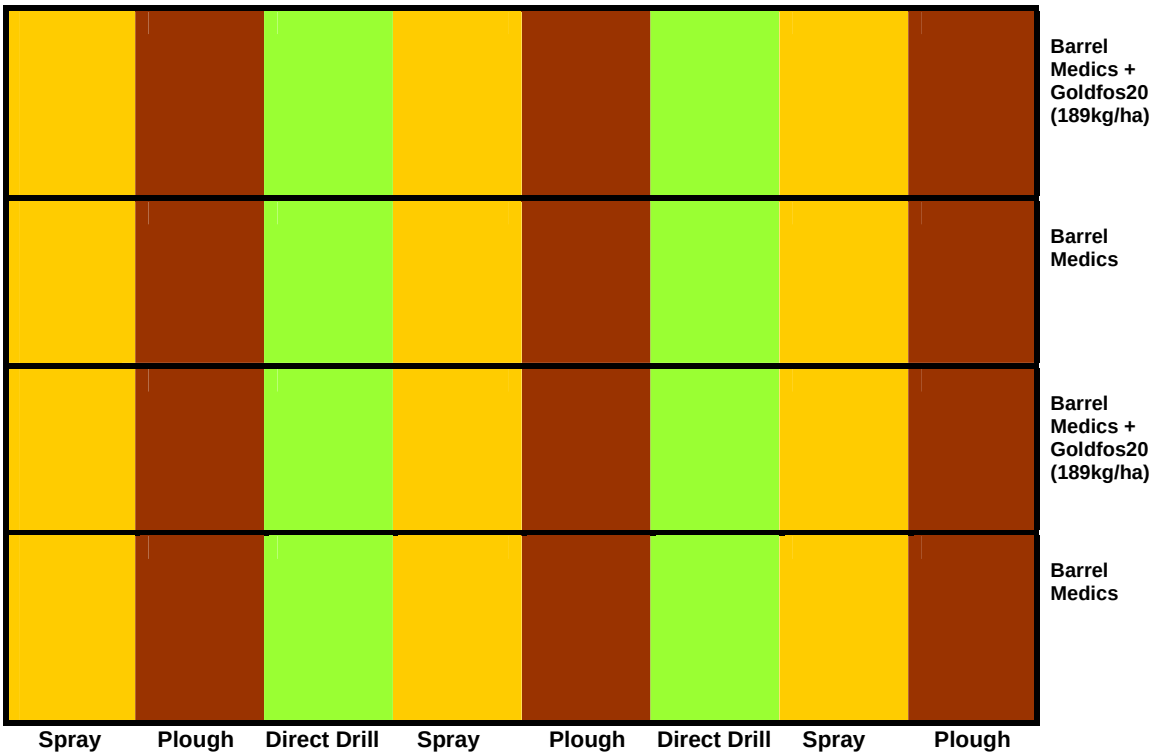
Property Name	Trial Area (ha)	Seed Bed Preparation	Sowing Method	Species Sown	Time of Sowing	Sowing Rate
'Lenroy'	0.7	Two passes with an offset plough and bandseeder before the sub-surface application of nitrogen and phosphorus.	Direct drill with a bandseeder.	Burgundy bean *(Macroptilium bracteatum).*	22/11/10	A legume mix @ 7kg/ha
				Round-leaf cassia var Wynn (*Chamaecrista rotundifolia).*	22/11/10	
				Caatinga stylo (*Stylosanthes seabrana)*.	22/11/10	
				Butterfly pea *(Clitoria ternatea).*	22/11/10	
'Catherinvale'	2.9	Strips of land – ▪ sprayed out Roundup 450. ▪ ploughed with a disc plough.	Direct drill with a bandseeder.	Barrel & burr medics (*Medicago truncatula* & *Medicago polymorpha* var brevispina).	15/07/10	

'Blue Hills'	5.9	Two passes with an offset plough and bandseeder before the sub-surface application of nitrogen and phosphorus.	Direct drill with a bandseeder.	Round-leaf cassia var Wynn (*Chamaecrista rotundifolia).* Caatinga stylo (*Stylosanthes seabrana).* Butterfly pea *(Clitoria ternatea).*	22/11/10	A legume mix @ 7kg/ha

FIGURE 2 - A summary of agronomical practices

Trial Site Design

"Catherinvale" trial site.



1) Three (3) types of trail site preparation.
    a. Grass *sprayed-out* with glyphosate and legume direct-drilled into the undisturbed pasture with & without fertiliser applications (Gold Phos 10H).
    b. Full mechanical *seedbed* preparation and legume direct-drilled into tilled soil with and without fertiliser applications.
    c. *Direct-drill* into pastures without any preparation, with and without fertiliser applications.
2) Winter medics planted on the 20th July 2010 @ a rate of 4kg/ha.

"Blue Hills" trial site

Caatinga Stylo + Gold Phos 10H @ 54kg/ha **Caatinga Stylo**	**0.5 ha**
Wynn Cassia+ Gold Phos 10H @ 54kg/ha **Wynn Cassia**	**0.5 ha**
Barrel Medics+ Gold Phos10H @ 54kg/ha **Barrel Medics**	**1 ha**

Upper slope

Contour bank

Caatinga Stylo + Gold Phos10H @ 54kg/ha **Caatinga Stylo**	**0.5 ha**
Wynn Cassia + Gold Phos10H @ 54kg/ha **Wynn Cassia**	**0.5 ha**
Barrel Medics + Gold Phos10H @ 189kg/ha **Barrel Medics**	**1 ha**

Mid slope

Contour bank

Caatinga Stylo + Gold Phos10H @ 54kg/ha **Caatinga Stylo**	**0.5 ha**
Wynn Cassia + Gold Phos10H @ 54kg/ha **Wynn Cassia**	**0.5 ha**
Barrel Medics + Gold Phos10H @ 108kg/ha **Barrel Medics**	**1 ha**

Lower slope

- Winter legumes were planted on the 20th July 2010 @ a rate of 4kg/ha..
- Summer legume mix planted on the 25th of November @ a rate of 4kg/ha.

"Lenroy" trial site

Germination Rate - 0-3 plants/m/row with rows @ 1m spacing's.	**Germination Rate** – 0-6 plants/m/row with rows @ 1m spacing's.	**Germination Rate** – only an odd plant germinated. Plants were not numerous but seed did	**Germination Rate** 1 plants/5m/row with rows @ 1m spacing's. Plants were sparse in the 1st growing

Goldfos10 applied @ a rate of 189 kg/ha

Rating : 1	Rating: 2	emerge from the initial planting. Rating: 3	season. Rating: 4
Germination Rate - 0-3 plants/m/row with rows @ 1m spacing's.	**Germination Rate** – 0-6 plants/m/row with rows @ 1m spacing's.	**Germination Rate** – only an odd plant germinated.	**Germination Rate** 1 plants/5m/row with rows @ 1m spacing's.
Wynn cassia 0.35 ha	**Caatinga Stylo 0.35 ha**	**Butterfly Pea 0.35 ha**	**Burgundy Bean 0.35 ha**

- The summer legumes were sown on the 22nd of November 2010 into a fully tilled seed bed with a full profile of soil moisture. However 646mm of rainfall was recorded between the 30th of November 2010 and the 11th of April 2011 resulting in poor germination and subsequent sparse plant establishment.

Results

"Catherinvale" trial site

Moderate germination rate & mature plants bigger than unfertilized.	**The Buffel grass population has diminished & medics established well.**	**Germinated readily after sowing but ultimately out-competed by the other plots.**	**Moderate germination rate & mature plants bigger than unfertilized.**	**The Buffel grass population has diminished & medics established well.**	**Germinated readily after sowing but ultimately out-competed by the other plots.**	**Moderate germination rate & mature plants bigger than unfertilized.**	**The Buffel grass population has diminished & medics established well.**	**Barrel Medics + Gold Phos 10H @ 189kg/ha.**
Moderate germination rate.	**The Buffel grass population has diminished & medics established well.**	**Germinated readily after sowing but ultimately out-competed by the other plots.**	**Moderate germination rate.**		**Germinated readily after sowing but ultimately out-competed by the other plots.**	**Moderate germination rate.**		**Barrel Medics**
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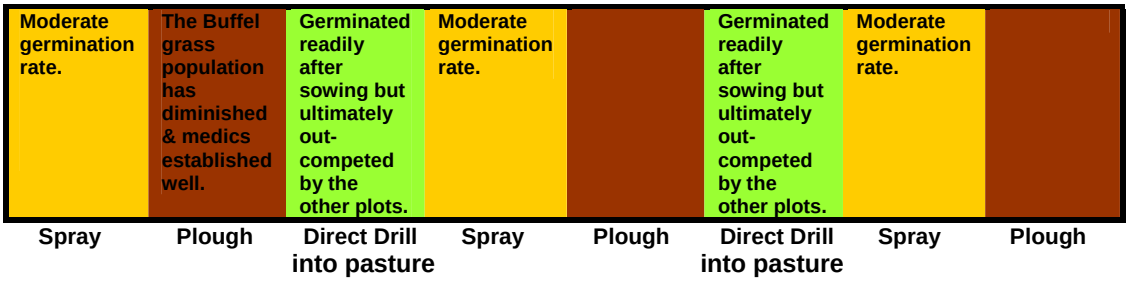


1) '*Direct drilling*' into the pasture sward resulted in the earliest germination and plant establishment.

2) The plots that were '*sprayed out*' with Roundup 450 originally colonised the fastest.

3) The fertilised plots grew medic plants that were more vigorous and larger in size than the unfertilized plots.

4) The trial plots were preferentially selectively grazed by stock (beef cattle) in winter/spring.

"Blue Hills" trial site

Caatinga Stylo + Gold Phos 10H @ 54kg/ha	**Established fairly well**	**0.5 ha**
Caatinga Stylo	**Established fairly well**	
Wynn Cassia + Gold Phos 10H @ 54kg/ha	**Established fairly well**	**0.5 ha**
Wynn Cassia	**Established fairly well**	
Barrel Medics+ Gold Phos 10H @ 54kg/ha	**Established well**	**1 ha**
Barrel Medics	**Established well**	

Upper slope

Contour bank

Caatinga Stylo + Gold Phos 10H @ 54kg/ha	**Established fairly well**	**0.5 ha**
Caatinga Stylo	**Established fairly well**	
Wynn Cassia + Gold Phos 10H @ 54kg/ha	**Established fairly well**	**0.5 ha**
Wynn Cassia	**Established fairly well**	
Barrel Medics + Gold Phos 10H (54kg/ha)	**Established well**	**1 ha**
Barrel Medics	**Established well**	

Mid slope

Contour bank

Caatinga Stylo + Goldfos20 (54kg/ha)	**Established very well**	**0.5 ha**
Caatinga Stylo	**Established very well**	
Wynn Cassia + Goldfos20 (54kg/ha)	**Established very well**	**0.5 ha**

Wynn Cassia	**Established very well**
Barrel Medics + Goldfos20 (54kg/ha)	**Established well**
Barrel Medics	**Established well**

1 ha

Lower slope

- Wynn cassia has established well *throughout* the trial plots amongst the Buffel grass and appears to be competing well the mature Buffel grass pasture of approximately 3500kg/ha.
- Caatinga stylo has heavily colonised *patches* of the plots and seedlings are growing between the individual Buffel grass clumps.
- The fertilised plots show no clear advantage in terms of legume population or vigor of plants.
- There is a larger population of summer legumes in the lower slope section of the trial plot.
- The winter legume species sown germinated fairly evenly throughout the plots it was sown.

"Lenroy" trial site

Mature vigorous plants are present @ a rate of 3-6/m2 throughout the plots.	Established well and a vigorous population of 2nd generation mature plants and seedlings are present in isolated clumps.	Small isolated populations of established plants are present & currently flowering & setting seed.	Germinated & established well but was decimated by wild pigs in 2010 before flowering. Isolated plants are currently present.
Mature vigorous plants are present @ a rate of 3-6/m2 throughout the plots. .	Established well and a vigorous population of 2nd generation mature plants and seedlings are present in isolated clumps.	Small isolated populations of established plants are present & currently flowering & setting seed.	Germinated & established well but was decimated by wild pigs in 2010 before flowering. Isolated plants are currently present.
Wynn cassia 0.35 ha	**Caatinga Stylo 0.35 ha**	**Butterfly Pea 0.35 ha**	**Burgundy Bean 0.35 ha**

Gold Fos10H applied @ a rate of 189 kg/ha

- The thorough seed bed preparation has disturbed and killed most of Buffel grass and in its place native pasture species have emerged including Sabi grass, Windmill grass, Love

grasses, Kangaroo grass, Forest bluegrass, Queensland bluegrass and White speargrass. Some Buffel grass plants have grown from seed. *See appendix for scientific names.*

- *Caatinga stylo* has thickened up in the 2011/12 spring/summer to form stands and a significant population is well established and has flowered and seeded again.

- *Wynn cassia* has spread from where it was originally sown and colonised the pasture sward of native grasses over the 2011/12 spring/summer period. It has colonised the trial plots significantly

- Burgundy bean establishes and grows well in summer seasons with adequate rainfall. Burgundy has a high percentage of 'hard seed' that does not germinate when it is initially planted. Isolated plants are present. Burgundy bean roots are a preferred food of wild pigs which uproot the entire plant when they dig.

Discussion / Conclusion

The change in seasons from drought conditions prior and up to 2009 to floods in 2010/11 has had a dramatic impact on the pasture systems of the Maranoa region as plant available water (PAW) is often one of the most limiting nutrients in the soils of the region. The grass species in the trial plots have had three (3) wet summer seasons to germinate, grow, mature and set seed. As a result the plot areas currently carry a diversity of pasture species with a estimated yield of between 2500kg/ha to 4000kg/ha of dry matter. It is difficult to isolate the influences of seasonal conditions, the introduction of legume species, soil disturbance or nutrients from fertiliser on the pasture responses and growth. Such information may become more apparent over time as pasture plant species interact with their environment and each other.

The recent and current seasonal conditions have favored seedling establishment, especially on the lighter soils, and competition for water with the highly competitive Buffel grass has not been a factor limiting seedling establishment. How the legume species sown in this trial will persist over time is still impossible to ascertain at this present time.

Since the Donnybrook group PIRD legume trial was commenced the issue of pasture run-down in the Maranoa region has become a focus of research and extension. The knowledge and experienced gained by all the people in this trial is very timely as it is contributing to the momentum required to initiate the need for innovation and change in order to address the pasture run-down problem.

Expert advice was sort on the topic of soil organic matter levels and soil carbon, and the rate of change pastures have on the rates of soil organic matter and carbon stored in the soil. Current technology to measure soil carbon levels indicates that the time frame required to identify an increase in soil carbon levels under pasture is much longer than the time frame of this trial. It was decided that a second round of soil sampling and soil testing would not be carried out.

Fields Days

A pasture run-down field day was planned to be conducted in the summer/autumn period of 2011/12 but a wet season resulted in postponed field days and landholders being behind on their farming calendars. Due to the limited opportunities for field days due to the weather none have yet been held. It is very highly that the trial sites will be used in 2012 for a field day and farm walk to highlight the results of this trial.

Comments by the Trial Participants

In attempt to make the discussion points easy to read I have listed the points raised in discussions with the landholders in dot point form.

- The three (3) landholders have appreciated the opportunity to conduct the legume trial and are finding the results very interesting.

- Although the weather has being less than ideal the results are very positive.

- Trial would deliver more conclusive results if they conducted over longer time frames in order to detect changes in soil nutrient levels, pasture biomass production (kg/ha/mm rainfall) and livestock daily live weight gain (DLWG).

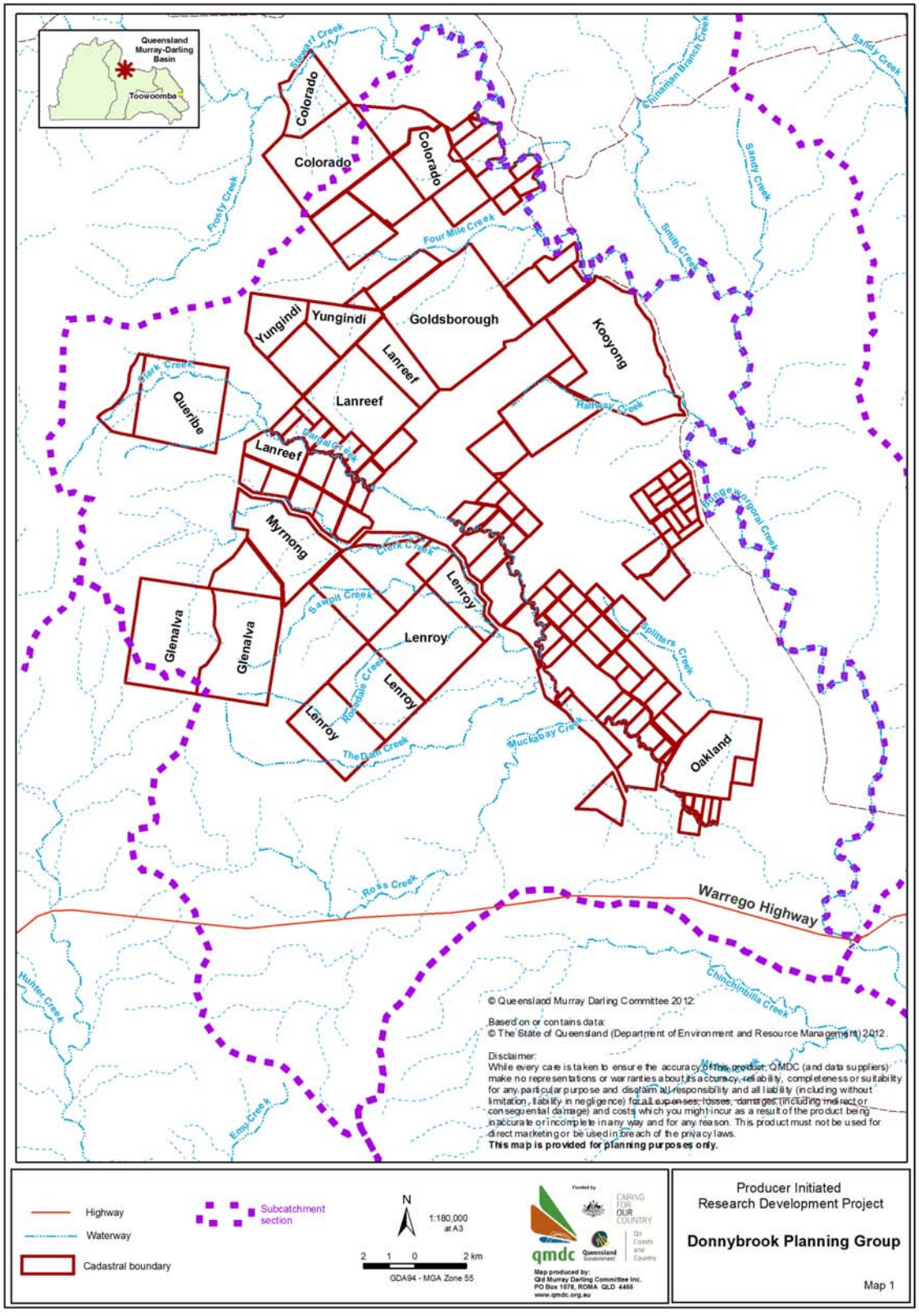
Bibliography

Henry, D. R. et al 1995, *"Pasture Plants of Southern Queensland",* Department of Primary Industries, Queensland.

Appendix

Common Grass Species of the Maranoa

Property Name	Soil Type	Pasture Species (common name)	Pasture Species (*scientific name)*
'Lenroy'	Duplex red/brown vertosols prone to surface sealing.	Buffel grass (sown)	*Cenchrus ciliaris*
		Rhodes grass (sown)	*Chloris gayana*
		Queensland bluegrass	*Dicanthium sericeum*
		Forest bluegrass	*Bothriochlora bladhii*
		Sabi grass	*Urochloa mosambicensis*
		Kangaroo grass	*Themeda triandra*
		Yabilla grass	*Panicum spp*
		Black speargrass	*Heteropogon contortus*
		Windmill grasses	*Enteropogon acicicularis*
			Enteropogon ramosus
'Catherinvale'	Duplex red/brown vertosols prone to surface sealing.	Buffel grass (sown)	*Cenchrus ciliaris*
		Queensland bluegrass	*Dicanthium sericeum*
		Forest bluegrass	*Bothriochlora bladhii*
		Sabi grass	*Urochloa mosambicensis*
		Kangaroo grass	*Themeda triandra*
		Yabilla grass	*Panicum spp*
		Black speargrass	*Heteropogon contortus*
		Windmill grasses	*Enteropogon acicicularis*
			Enteropogon ramosus
'Blue Hills'	Stony shallow brown vertosols of moderate fertility over a sodic sub-soil.	Buffel grass (sown)	*Cenchrus ciliaris*
		Queensland bluegrass	*Dicanthium sericeum*
		Forest bluegrass	*Bothriochlora bladhii*
		Sabi grass	*Urochloa mosambicensis*
		Kangaroo grass	*Themeda triandra*
		Yabilla grass	*Panicum spp*
		Black speargrass	*Heteropogon contortus*
		Windmill grasses	*Enteropogon acicicularis*
			Enteropogon ramosus
		White speargrass	*Aristida spp.*


Queensland Murray-Darling Basin
Toowoomba
Colorado
Yungindi
Goldsborough
Kooyong
Lanreef
Querlbe
Myrnong
Glenalva
Lenroy
Oakland
Warrego Highway
Four Mile Creek
Frosty Creek
Sandy Creek
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