MEAT & LIVESTOCK AUSTRALIA

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More Beef from tropical pastures

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Abstract

The Dungog - Gresford Land & Beef Inc. group (DGLB) is an active beef producer group based in the Lower Hunter Valley of NSW interested in learning and sharing information relevant to the industry. Off interest to the group were new varieties of subtropical grasses and companion legumes and which may have the ability to persist and establish in both higher and lower fertility soils.

Overall, while some novel legumes such as Gland Clover and Yellow Serradella performed well in the year of establishment, adapted cultivars of Sub Clovers (and especially White Clovers) still were best able to persist and produce biomass year on year. Experience during the research of these temperate legume options indicate that historical problems of clover persistence may have more to do with fertiliser management than species selection.

Of the subtropical grasses trialled *Solander setaria* and *Chloris gayana* (Callide Rhodes Grass) gave the best production on low fertility soils and Megamax 509 Panic proved equally productive to these on a higher fertility site.

The combination of high biomass producing subtropical grasses along with persistent temperate legumes should enable a two to four fold increase in land productivity compared with the current systems dominated by weeds such as blady grass.

Executive summary

The aim of this research was to trial new varieties of temperate legumes and sub tropical grasses which could be successfully established and managed to increase beef production in the Dungog – Gresford districts. The project investigated options to incorporate temperate legumes into two existing pasture systems, firstly low fertility hill country, and also the more fertile areas with kikuyu based pasture. It was also important that any of the species that were successfully established could also persist over time.

Seven trials were set up over four sites and in each case sites were prepared by spraying a Glyphosate based herbicide. The four legume trials (1, 2, 4 and 5) utilised a split plot design, with only half the plots sprayed out to also test the impact of controlling weeds and suppressing the background perennial grass before sowing, compared to sowing into an actively growing pasture sward. All trial sites were direct drilled, though the second legume trials (4 and 5) had a broadcast comparison using the better performing legumes from trials 1 and 2.

While a number of the novel legumes trialled did establish and produce well in the year of sowing, the more conventional legumes regenerated/persisted better producing more biomass in the year after sowing. In the year of sowing the best novel legumes were Gland Clover and Santorini Yellow Serradella regardless of the site. Bladder Clover also performed well in the initial year - but only on the high fertility site. In general, these legumes performed on par with the more conventional white clover and sub clover cultivars in the year of sowing.

In the following year, of the novel legumes, only the Santorini Yellow Serradella regenerated successfully but only on the high fertility site. By comparison, both cultivars of Sub clover and the White clover regenerated/persisted well at both sites, producing 50-100% more biomass than the serradella at the high fertility site. While further development of serradella cultivars may create new opportunities this research concluded that the traditional white clover remained the most persistent and productive option provided soil fertility deficiencies were addressed.

Establishment method was tested for Prima Gland Clover, Antas Sub Clover and Haifa White Clover, comparing drilled and broadcast sowing methods both with and without herbicide weed suppression. While it was clear that none of the legumes could be established regardless of sowing method when plots remained unsprayed, the sprayed plots demonstrated no significant difference between the sowing methods in terms of establishment or biomass production for the cultivars under investigation.

The subtropical grasses trialled included Premier Digit, 3 cultivars of Rhodes Grass, 2 cultivars of Setaria, 2 cultivars of Panic, 2 cultivars of Paspalum 2 cultivars of Kikuyu, Bisset Bluegrass and Sabi grass. Tropical legumes trialled included Wynn Rounded Cassia, Shaw Creeping Vigna and Desmanthus. Of the grasses sown, Setaria and Rhodes grass displayed the best general results in terms of biomass and could be grown successfully on both lower and higher fertility soils persisted over two consecutive years on the low fertility site. Megamax Panic also grew well on the higher fertility site. Kikuyu, while not as productive in terms of total biomass, did produce biomass of generally higher quality. This highlighted the need for close management of the taller growing pasture species to keep biomass in check and to maintain higher feed quality longer into the

summer. All three of the tropical legumes tested failed to establish successfully at the low fertility site at Bonnington.

The more productive subtropical grasses were seen as very successful and they have subsequently been used by local beef producers on their own properties on extensive areas. The grasses were trialled in the hope of finding a species that could replace and compete against reinvasion by blady grass and other low palpability species predominately in steeper low fertility back country.

Extreme weather conditions, including both drought and flood, played a significant part in the trials delaying sowing and hampering the ability to carry out pasture cuts as per plan as growth was delayed or access cut off.

Other key findings from the three years of trials included:

- a necessity to spray out existing herbage to assist germination and establishment of the sown species.

- the value in the use of starter fertiliser at sowing and ongoing fertiliser during establishment to maintain sufficient nutrient for new sowings to perform especially the legumes.

- the need to manage herbage mass in late summer to allow space for the legumes to regenerate in the autumn.

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1 Background

The DGLB group was formed over 30 years ago principally to run a hoof and hook competition to allow their cattle to be assessed both on the hoof by an independent judge and follow their animals through the abattoir system judging – hence the group was originally named Dungog - Gresford Hoof & Hook Group. A name change became necessary as the years progressed and the group developed and diversified from a hoof and hook competition.

The group is now active in keeping producers up to date with technical improvements and changes in the industry, as well as evolving market trends, legislative requirements and other relevant opportunities or impacts to productivity. The group also runs field days, information sessions and educational farming tours within NSW, Qld and New Zealand. Producers in the group realised the importance of pasture improvement and the need for knowledge to enable them to increase productivity and generate more profit.

The group currently has around 40 producer members, with the majority consistently involved in the group activities. Total land area managed by the DGLB group members is around 15200 hectares with approximate 10,500 beef cattle in total.

Many of the producers in the district have unimproved back country with low quality grass weeds such as blady grass and were motivated to identify new varieties of sub tropical grasses and legumes which could be successfully established and be managed to persist and increase beef production in these areas. An additional aim was to find legumes not previously trialled in the area which might persist better than the traditional Haifa white clover in dense high fertility kikuyu based pastures already established on the more productive soils.

2 Projective objectives

This project goal was to investigate options to incorporate legumes into subtropical pasture systems in the Dungog-Gresford area of NSW. Supplementary to this objective was research to determine the adaptation and establishment method for improved subtropical grass species. In this region, white clover is the preferred legume and this project will compare methods to establish and incorporate white clover and alternative legumes into existing tropical pastures. The following are the key project objectives:

2.1 Evaluated the potential for a range of new legume species to be established in existing C4 grass pastures on both low and higher fertility soils.

2.2 Evaluated the potential of broadcasting methods to establish legumes into existing tropical pastures compared to direct drilling.

2.3 Evaluated the production and quality of pastures that include novel legumes compared to the current district practise (white clover) and the site baseline of no legume

2.4 Evaluated the potential of a range of improved tropical grass species to replace low quality pastures on low fertility soils

3 Methodology

3.1 Research sites

Trial sites were originally planned for two properties, one at Marshdale near Dungog and the other at Allynbrook, near Gresford. Due to unforeseen events during the project, trials were also located on another two properties at Glen Oak and Clarence Town. All properties are located in the lower Hunter Valley in NSW.

3.1.1 Site 1 "Bonnington"

Located on the Allyn River about 12 kms north of East Gresford. The site is 1 km west of the river on a northeastern slope. Latitude and longitude coordinates of the site are 32°20'22.72'' S – 151°31'41.73'' E. Average annual rainfall is 950 mm. The soil is a yellow podsolic – initial soil test results were pH 5.1 and Colwell Phosphorous 25. This site was chosen to be representative of unimproved land in the area and was accessible to vehicles and was already within a small paddock on a large holding. The trial site was fenced off within this paddock.

3.1.2 Site 2 "Beddingdown"

Located on Beddingdown Creek 12 kms east of Dungog this site is on a north facing slope approximately 60 m from the creek in the Williams Valley. Latitude and longitude coordinates of the site are 32°25'22.65'' S - 151°48'55.87'' E. Average annual rainfall of 950mm. The soil type is yellow podsolic – initial soil test results were pH 5.0 and Colwell Phosphorus 210. This site was chosen for its high soil fertility and existing kikuyu based pasture which suited the trial sowing of new legume species. The site had vehicular access and it required no further fencing. Over the years it has had regular applications of chicken litter.

3.1.3 Site 3 "Oakendale "

Located on Tumbledown Creek 8 kms south of Clarence Town the "Oakendale" site is on level ground approximately 100 m from the creek which feeds directly into the Williams River. Latitude and Longitude coordinates of the site are 32°59'76.64'' S -151°71'47.18'' E. Average annual rainfall is 860mm.The soil is alluvial and initial soil tests results were pH 5.0 and Colwell Phosphorus 120. This site was chosen as an alternative high fertility, kikuyu site when the Beddingdown site was found to be unsuitable for a second trial due to self-sown clover on the proposed site. Oakendale had high soil fertility and an existing kikuyu based pasture and was chosen to allow the second legume trial. Over the years it has had applications of fertiliser.

3.1.4 Site 4 "Bonhomie"

Located 5 kms north of Clarence Town on Stoney Creek the "Bonhomie" site is on level ground consisting of a mix of native and improved pasture. Latitude and longitude coordinates are 32°58'50.80'' S – 151°77'75.11'' E. Average annual rainfall is 860mm.

The soil type is alluvial and initial soil tests results were pH 4.5 and Colwell phosphorus 80. This site was chosen to expand the trial of Sub Tropical grasses following the success of particular species at "Bonnington "and in nearby commercial plantings.

3.2 Treatments

All of the trials were a randomised block design with three replicates of the various grass and legume cultivars plus a control. Plots were 2m in width (which was the width of the John Deere seeder used). The length of the plots was 50 metres. All trials were setup in the same format using the same seeder for consistency. The seeder was vacuum cleaned between each cultivar to prevent cross contamination of seeds.

Figure 1. Seeder used at sowing of trials

3.2.1 Trial 1. Legume Site 1 "Bonnington" established May 2014

The trial was electrically fenced within the existing paddock and then heavily grazed to remove the existing herbage. It was followed up with a treatment of Glyphosate 360 at a rate of 8 litres / ha on 50 % of the area to allow a comparison of sprayed versus unsprayed presowing preparation. All plots received Croplift 15 (N14.6%, P12.0%, S11.6%) starter fertiliser at a rate of 113 kg / ha.

Seven legume varieties were sown:

- Haifa White Clover (control) (6 kg/ha)
- Gland Clover (6kg/ha)

- Casbah Biserrula (6kg/ha)
- Bartolo Bladder Clover (8kg/ha)
- Santorini Serradella (8kg/ha)
- Antas Sub Clover (10kg/ha)
- Campeda Sub Clover (10 kg/ha)

3.2.2 Trial 2 Legume Site 2 "Beddingdown" established June 2014

Trial was within an existing paddock and heavily grazed to remove the existing herbage. It was followed up with a treatment of Glyphosate at a rate of 8 litres / ha on 50 % of the area to allow a comparison of sprayed versus unsprayed. All plots received Croplift 15 starter fertiliser at a rate of 113 kg / ha.

Seven legume varieties were sown:

- Haifa White Clover (control) (6 kg/ha)
- Gland Clover (6kg/ha)
- Casbah Biserrula (6kg/ha)
- Bartolo Bladder Clover (8kg/ha)
- Santorini Serradella (8kg/ha)
- Antas Sub Clover (10kg/ha)
- Campeda Sub Clover (10 kg/ha)

3.2.3 Trial 3 Subtropical Grasses Site 1 "Bonnington" established June 2015

Trial 3 was adjacent to the existing legume trial at "Bonnington'. The trial remained in the area already fenced off from cattle. This site was sprayed out with Glyphosate 360 at a rate of 8lt /ha three weeks prior in preparation for sowing but had to be resprayed ten days before planting as heavy rain delayed sowing and excessive plant growth had reoccurred. All plots received Croplift 15 starter fertiliser at a rate of 154 kg / ha.

The varieties of subtropical grasses and legumes sown were:

- Premier Digit Grass (6kg/ha)
- Callide Rhodes Grass (8kg/ha)
- Bisset Creeping Bluegrass (6kg/ha)
- Solander Setaria (6kg/ha)
- Common Paspalum (hand broadcast – would not work in seeder)
- Wynn Rounded Cassia- Legume (8kg/ha)
- Shaw Creeping Vigna –Legume (10kg/ha)
- Desmanthus –Legume (8kg/ha)

3.2.4 Trial 4: Sowing Method. Site 3 "Oakendale" established June 2015

Trial 4 used the best three performing legumes from the first two trials with a focus on comparing direct drill versus broadcast sowing methods. Other legume varieties were sown using direct drill

only. The trial was relocated to “Oakendale“ due to the proposed new “Beddingdown "site being overgrown with naturally occurring white clover following hard grazing to control the Kikuyu.

The “Oakendale” site was sprayed out with Glyphosate 360 at a rate of 8lts per ha. Single super (P8.8%, S 11.0%) was used at sowing at a rate of 150kg /ha.

Nine varieties of legumes were sown:

	Direct Drilled	Broadcast
– Cobra Balansa Clover (8kg/ha)	✓	
– Bartolo Bladder Clover (8kg/ha)	✓	
– Clare 2 Sub Clover (10kg/ha)	✓	
– Persian Clover (6kg/ha)	✓	
– Arrow Leaf Clover (8kg/ha)	✓	
– Cavalier Medic (8kg/ha)	✓	
– Antas Sub Clover (10kg/ha)	✓	✓
– Haifa White Clover (6kg/ha)	✓	✓
– Gland Clover (6kg/ha)	✓	✓

3.2.5 Trial 5: Sowing Method. Site 2 “Bonnington” established June 2015

This trial re tested the better performing legumes from the first trial in addition to some new legume varieties (similar to trial 4). The site was sprayed with Glyphosate 360 at a rate of 8 lts / ha. Mo superphosphate fertiliser was used at planting at a rate of 250kg /ha. This trial was planted as three replications and as for “Oakendale” the better performing legumes from trial 1 sown both broadcast and direct drilled.

Nine varieties of legumes were sown:

	Direct Drilled	Broadcast
– Cobra Balansa Clover (8kg/ha)	✓	
– Bartolo Bladder Clover (8kg/ha)	✓	
– Clare 2 Sub Clover (10kg/ha)	✓	
– Persian Clover (6kg/ha)	✓	
– Arrow Leaf Clover (8kg/ha)	✓	
– Cavalier Medic (8kg/ha)	✓	
– Antas Sub Clover (10kg/ha)	✓	✓
– Haifa White Clover (6kg/ha)	✓	✓
– Gland Clover (6kg/ha)	✓	✓

3.2.6 Trial 6: Second Grasses Trial. Site 2 “Bonnington” sown December 2016

Trial 6 is an additional trial which was conducted due to the success of some of the grasses in trial three, particularly the Setaria and the Rhodes Grass. Additional varieties of these two grasses were trialled along with the original varieties from trial 3 and some additional varieties of some other species The site was sprayed twice, first in early November 2016 and then just prior to sowing in

December 2016 with Glyphosate 360 at a rate of 8 lts / ha because a delay in sourcing the seed allowed naturally occurring pastures and weeds to regrow before sowing. Croplift 15 fertiliser was used at a rate of 154kg / ha.

Eleven varieties of grasses sown:

- Callide Rhodes Grass (8kg/ha)
- Katambora Rhodes Grass (8kg/ha)
- Toro Rhodes Grass (8kg/ha)
- Solander Setaria (6kg/ha)
- Narok Setaria (6kg/ha)
- Megamax 059 Green Panic (6kg/ha)
- Gatton Panic (6kg/ha)
- Sabi Grass (8kg/ha) – had to be hand sown – seed would not flow through the seeder
- Blue Dawn Paspalum Nicorea (8kg/ha)
- Acacia Kikuyu Grass (6kg/ha)
- Whittet Kikuyu Grass (6kg/ha)

3.2.7 Trial 7: Second Grasses Trial. Site 4 “Bonhomie” sown December 2016

This trial is of the same design as trial 6 with the purpose of testing the performance of successful species from Trial 3 particularly the Setaria and the Rhodes grasses in a different environment and soil type. As for trial 6 the site was sprayed with Glyphosate 360 at a rate of 8 lts / ha due to the delay in sowing while suitable seed was sourced. Croplift 15 fertiliser was used at sowing at a rate of 154kg per ha.

Eleven varieties of grasses sown:

- Callide Rhodes Grass (8kg/ha)
- Katambora Rhodes Grass (8kg/ha)
- Toro Rhodes Grass (8kg/ha)
- Solander Setaria (6kg/ha)
- Narok Setaria (6kg/ha)
- Megamax 059 Green Panic (6kg/ha)
- Gatton Panic (6kg/ha)
- Sabi Grass (8kg/ha) – hand sown – seed would not flow through the seeder
- Blue Dawn Paspalum Nicorea (8kg/ha)
- Acacia Kikuyu Grass (6kg/ha)
- Whittet Kikuyu Grass (6kg/ha)
- Normal text

3.3 Monitoring

All seven trials were monitored regularly by the group over the three year trial contract period.

Measurements taken

3.3.1.1 Seedling counts

Germination of newly sown pasture and regeneration in subsequent years was assessed using visual assessments and relative frequency. Relative frequency assessed using a steel mesh grid of 5 x 10 = 50 squares. Each square was 10 x 10 cm. Counts are presented as a percentage of squares containing the sown species or variety.

3.3.1.2 Establishment counts (Plant count)

The same technique was used as for seedling counts but at a later growth stage to determine the number of plants that successfully established.

3.3.1.3 Herbage mass

Herbage mass (yield) was assessed by cutting either 3 or 6, 50 x 50 cm quadrats (depending on the uniformity of the plots) from each plot that had assessable growth. Each quadrat sample was weighed wet then placed into a dehydrator at 80°C for 48 hours, then weighed dry.

3.3.1.4 Feed quality

Dried samples taken from dehydrator were sent to NSW DPI Feed Quality Service (FQS) laboratory at Wagga Wagga. Standard feed analysis package comprising Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Water Soluble Carbohydrate (WSC), Crude Protein (CP), Inorganic Ash, Organic Matter (OM), Dry Matter Digestibility (DMD), Dry Organic Matter Digestibility Matter (DOMD), and Metabolisable Energy (ME). CP and ME have been reported in detail.

3.3.1.5 Visual assessments

Formal visual assessment was conducted when group members inspected trial sites. Visual scoring was based on a subjective combination of ground cover and herbage mass. Scoring was 0–5 with 0 = zero sown variety present, 1 = trace only sown variety, through to 5 being very good/best present. Six to ten group members were present when visual assessments were undertaken. Scores from all members were averaged to give final visual score.

General observations, photographs and video were taken during regular site inspections.

3.3.1.6 Palatability

Palatability was assessed by observing grazing preference of cattle when they were given access to trial sites. Observations were taken when cattle first entered the trial site and again after 24 hours. The most palatable varieties were eaten first and most heavily grazed. The least palatable were barely touched after 24 hours.

3.3.2 Monitoring schedules

Trial 1 - Site 1 " Bonnington"- sown May 2014

August 2014	Seedling counts
October 2014	Plant counts taken – photos taken.
November 2014	Site inspection - photos taken.
December 2014	Site grazes off.
January 2015	Site grazed heavily over summer through to early autumn 2015.
February 2015	Site inspection by group members - photos taken.
June 2015	Group site inspection - photos taken.
December 2015	Site inspection by group members
October 2016	Group inspection of site - photos taken.
December 2016	Site inspection - photos taken.

Trial 2 - Site 2 " Beddingdown" sown May 2014

August 2014	Visual pasture seedling counts (as per the above method) by members of the group - photos taken.
October 2014	Plant counts taken – photos taken.
December 2014	Herbage mass measured.
December 2014	Site grazed with a total of 26 steers and heifers from end of December 2014 until start of March 2015.
May 2015	Group trial inspection by group members
October 2015	Trial inspection by group members - photos taken

Trial 3 - Site 2 " Bonnington" sown February 2015. Grasses Trial

June 2015	Group trial inspection - photos taken.
December 2015	Trial inspection of the site by group members and Neil Griffiths (DPI consultant agronomist) and Doug Alcock (State Co-ordinator). Annual meeting held at the same time.
October 2016	Trial inspection by group of 11 producers - a meeting also held at the same time.
December 2016	Site inspection - photos taken.

Trial 4 - Site 3 " Oakendale " sown June 2015. 2nd Legume

October 2015	Herbage biomass measured
October 2015	Property owner assessed the palatability of the legumes feeding off - ten cows and calves over a period of four hours on day one and four hours next day until eaten down.
November 2015	Site inspection by group - legumes regrowth.
December 2015	Second biomass assessment only the legumes still persisting.
September 2016	Site inspection and group meeting to discuss trials with Neil Griffiths DPI.
October 2016	Site grazed.

Trial 5 - Site 1 " Bonnington " established June 2015. 2nd Legume

October 2015	Herbage biomass measured using quadrat Five cuts were dried and weighed.
December 2015	Site inspection with 11 group members - including Neil Griffiths DPI and Doug Alcock Project Coordinator.
December 2015	Herbage Mass taken on only the legumes still persisting.
May 2016	Group trial inspection of the site by group members and Neil Griffiths (DPI Consultant Agronomist) - photos taken and Doug Alcock (State Co-ordinator). Field day held on site the same day.
October 2016	Group trial inspection and photos taken of only legume showing white Haifa.
December 2016	Group trial inspection of site.

Trial 6 - Site 1 " Bonnington" sown December 2016. 2nd Grasses Trial

February 2017	Trial site was inspected by property owner and two group members nothing visible due to drought.
May 2017	Site Inspected (as above) - trial failed to germinate. No further observations or measurements

Trial 7 - Site 4 " Bonhomie " sown December 2016. 2nd Grasses Trial

February 2017	Group trial inspection by four group members.
April 2017	Group trial inspection by group.
April 2017	Herbage biomass measured. Herbage samples sent FQS Wagga Wagga for feed analysis.

3.4 Statistical analysis

Statistical analyses were conducted using ASReml 4.1 (VSN International, 2017) when data were collected for two or more replicates.

3.4.1 Temperate legume evaluation (Trials 1 and 2)

Herbage mass (kg DM/ha) and establishment frequency (%) data for both sites were analysed independently using a simple randomised complete block design (with eight legume treatments and three replicates) with a generalised linear model with legume treatment as the fixed term. When the treatments were significantly different ($P < 0.05$) pairwise comparisons were conducted to calculate the least significant difference (LSD, $P = 0.05$).

3.4.2 Temperate legume and sowing method (Trials 4 and 5)

Herbage mass (kg DM/ha) collected on September, October and December 2015 and nutrient analysis of plant samples collected October and December 2015 for the two sites were combined for analysis. Data were analysed as randomised complete bock designs (12 temperate legume treatments and three replicates for two sites) using a generalised linear model with legume treatment as the fixed term and site/rep as the random term. When there were significant differences ($P < 0.05$) pairwise comparisons were conducted using least significant difference (LSD, $P = 0.05$).

3.5 Economic analysis (if applicable)

Not applicable

3.6 Extension and communication

Various methods were employed to make the local farming community and their service providers aware of the trial and the results.

- Dungog - Gresford Land & Beef meetings and site inspections
- Annual field days
- Presentation at seminars and annual dinner
- Newsletters
- Press and media releases

4 Results

4.1 Measured trial results

4.1.1 Temperate legume evaluation (Trials 1 and 2)

Sowing into existing pasture without a "knockdown" herbicide spray was completely unsuccessful. Establishment in the unsprayed area was too poor to enable any meaningful measurements to be taken. Thus the results below represent half of the trial plots only.

Herbage mass scored at both trial sites in August 2014 ranked Santorini yellow serradella with the highest herbage mass ($P < 0.05$; Table 1). At 'Bonnington', Haifa white clover, and Prima gland clover had similar herbage mass to Santorini yellow serradella. At 'Beddingdown', only Haifa white clover had similar herbage mass to Santorini yellow serradella. Casbah Biserrula had the lowest herbage mass at both sites ($P < 0.05$; Table 1).

Average seedling frequency assessed in October 2014 indicated that establishment was lower at 'Bonnington' than 'Beddingdown' (49% cf. 68%) due to higher quality soil at 'Beddingdown'. At 'Bonnington' Prima gland clover had the highest seedling frequency (87%; $P < 0.05$) but was not significantly different to Haifa white clover nor Antas and Campeda subterranean clovers. Seedling frequency of Santorini serradella (58%) was significantly lower but Bartolo bladder clover and Casbah Biserrula had the lowest seedling frequencies (2-18%; $P < 0.05$) which were not significantly different to the control (nil legume).

At 'Beddingdown', Campeda subterranean clover had the highest seedling frequency (98%; $P < 0.05$), but was similar to both Antas subterranean clover and Haifa white clover ($P > 0.05$). Prima gland clover was ranked equal 4th with a frequency similar to the subterranean clovers and white clover. Casbah Biserrula had the lowest seedling frequency (32%) which was greater than the control ($P < 0.05$).

In November 2014, herbage mass assessed on the four legumes with significant growth ranged 2400-3643 kg DM/ha. Antas subterranean clover had the highest herbage mass but it was only significantly different to Campeda subterranean clover which had the lowest herbage mass ($P < 0.05$).

Table 1. Herbage mass (score, kg DM/ha) and seedling frequency (%) of legumes assess during their establishment year at 'Bonnington' and 'Beddingdown'. LSDs (P = 0.05) are provided.

	'Bonnington'		'Beddingdown'		
Legume and cultivar	Herbage mass (score) August 2014	Seedling frequency (%) October 2014	Herbage mass (score) August 2014	Seedling frequency (%) October 2014	Herbage mass (kgDM/ha) November 2014
Biserrula cv. Casbah	0.8	2	1.3	32	-
Bladder clover cv. Bartolo	1.6	19	2.1	61	-
Control (nil legume)	0.1	0	0.7	0	-
Gland clover cv. Prima	2.5	87	2.5	84	3147
Subterranean clover cv. Antas	2.1	67	2.6	95	3643
Subterranean clover cv. Campeda	2.1	72	2.2	98	2400
White clover cv. Haifa	2.7	86	2.9	90	2812
Yellow serradella cv. Santorini	2.9	58	3.5	84	
LSD (P = 0.05)	0.74	21.6	0.68	10.6	975.8

In October 2015, only three legumes at 'Bonnington' and four legumes at 'Beddingdown' had regenerated and produced sufficient herbage for sampling and nutritive value analysis. At 'Bonnington' herbage mass ranged from 2733kg (Antas subterranean clover) to 5827 kg DM/ha (Campeda subterranean clover) (data not analysed).

Haifa white clover was intermediate, with 3547 kg DM/ha recorded and also the highest CP concentration (17.2%) and lowest NDF concentration (45%). The three legumes had similar ME (9.3-9.6 MJ/kg DM), with Antas subterranean clover recording the highest WSC concentration (6.7%).

At 'Beddingdown', Santorini yellow serradella, Antas and Campeda subterranean clover and Haifa white clover were the legumes that regenerated. Herbage mass ranged from 1467kg (Santorini yellow serradella) to 4187kg DM/ha (Antas subterranean clover) (data not analysed). Similar to the other site, Haifa white clover had the highest CP concentration (17.3%) and lowest NDF concentration. It also had the highest ME levels (9.4 MJ/kg DM). In contrast, Santorini yellow serradella had the lowest CP, ME and NDF concentration of the five legumes. The site had started to senesce. The two subterranean clover cultivars had the highest WSC concentrations (5.5-6%) while the other legumes had levels less than 4.0%. Care should be taken in the interpretation of these feed quality data as the legumes tested had differing maturity patterns and were in different phases of growth at the time of sampling. White clover in particular, being a perennial, was exhibiting fresher growth compared with the annual legumes, which had completed their phenological cycle and begun to senesce.

Table 2. Herbage mass (kg DM/ha) and nutritive value of five legumes in October 2015. Nutritive value shown are crude protein (CP, %), metabolisable energy (ME, MJ/kg DM), water soluble carbohydrate (WSC, %) and neutral detergent fibre (NDF, %). Data are of a single replicate only and therefore not analysed.

Legume and cultivar	Herbage mass (kg DM/ha)	CP (%)	ME (MJ/kgDM)	WSC (%)	NDF (%)
	'Bonnington'				
Yellow serradella cv. Santorini	-	-	-	-	-
White clover cv. Haifa	3547	17.2	9.3	4.3	45
Gland clover cv. Prima	-	-	-	-	-
Subterranean clover cv. Antas	2733	12.0	9.6	6.7	49
Subterranean clover cv. Campeda	5827	14.8	9.3	4.5	49
	'Beddingdown'				
Yellow serradella cv. Santorini	1467	9.6	6.4	<4.0	67
White clover cv. Haifa	2120	17.3	9.4	<4.0	45
Gland clover cv. Prima	-	11.3	8.0	<4.0	52
Subterranean clover cv. Antas	4187	13.8	9.2	6.0	51
Subterranean clover cv. Campeda	2373	12.5	9.0	5.5	53

4.1.2 Subtropical grasses (Trial 3)

Poor seasonal conditions were experienced during the germination and establishment phase of this trial. Of the five Subtropical grasses and three tropical legumes sown, only two grasses were able to establish, persist and produce any biomass. Only Callide RhodesGrass and Solander Seteria established sufficiently to cut in May 2016. No statistical analysis was conducted on these due to the failure of too many treatments, however feed quality tests were conducted and averages are shown in Table 3.

Table 3. Nutritive value of subtropical grasses present at 'Bonnington' in May 2017. Neutral detergent fibre (NDF, %), crude protein (CP, %), metabolisable energy (ME, MJ/kg DM) and water soluble carbohydrate (WSC, %) were analysed and averaged over three replicates.

	NDF	CP	ME	WSE
Callide Rhodes	92.3	5.3	7.3	5.4
Setaria Solander	92.8	7.0	7.7	5.2

4.1.3 Temperate legume and sowing method (Trials 4 and 5)

Due to good seasonal conditions and unseasonal high rainfall there was no noticeable difference between broadcast and direct drilled sowing methods.

Herbage mass of Prima gland clover, Haifa white clover and Antas subterranean clover assessed in September and October 2015 showed no difference due to seeding method (shallow sown with a disc seeder vs being placed on the soil surface by broadcasting) ($P > 0.05$; Figure 1).

In September 2015, Haifa white clover had the highest herbage mass score ($P < 0.05$), and similar to Persian clover ($P > 0.05$). Bartolo bladder clover had the lowest herbage mass score ($P < 0.05$) and was similar to Zulumax arrow leaf and Cavalier burr medic (Figure 1a).

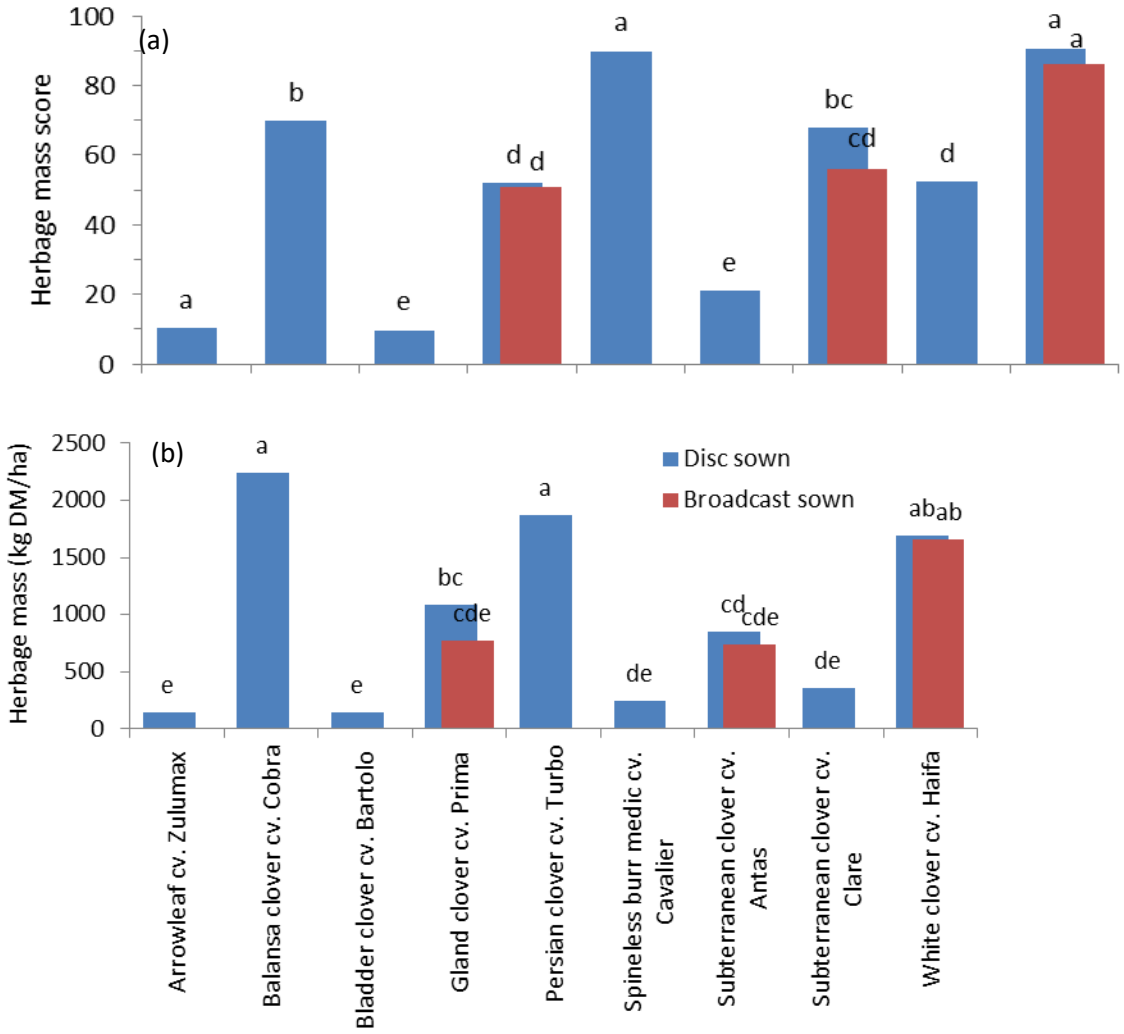

Figure 1. Legume herbage mass at 'Oakendale' and 'Bonnington' (averaged across the sites) in (a) September (score) and (b) October 2015 (kg DM/ha). The legumes at both sites were shallow sown with a disc seeder, with three legumes also surface sown by broadcasting. (Treatments marked with the same letter are not significantly different).

By October 2015, herbage mass ranged from 140 kg DM/ha (Zulumax arrow leaf clover and Bartolo bladder clover) to 2240 kg DM/ha (Cobra Balansa clover) ($P < 0.05$). Turbo Persian clover and Haifa white clover had high herbage mass similar to Cobra Balansa (Figure 1b). Zulumax arrow leaf clover, Bartolo bladder clover, Cavalier burr medic, Clare and Antas subterranean clovers and Prima gland clover had low herbage mass.

Nutritive value of the legumes in October 2015 was variable and partly associated with their growth stage at the time of assessment (Table 4). Crude protein ranged from 13% for Prima gland clover to 21% for Persian clover ($P < 0.05$). Bartolo bladder and Haifa white clover also had high crude protein levels similar to Turbo Persian clover. Similarly ME ranged from 9.3 (Prima gland clover) to 11.3 MJ/kg DM (Bartolo bladder clover), with Turbo Persian clover and Haifa white clover having similarly high ME levels. These three legumes also had the lowest NDF concentration (38-39%) while Prima gland clover had the highest (48%; $P < 0.05$). Cavalier burr medic and Bartolo bladder clover had the highest WSC concentrations (14.0 and 11.5% respectively) followed by Zulumax arrow leaf clover

(10.9%). The remainder of the legumes had significantly lower but similar WSC concentrations ranging 4.4-7.1% (P < 0.05).

By December 2015 all legumes but Zulumax arrow leaf clover, Haifa white clover and Turbo Persian clover had senesced. Herbage mass of the legumes were not significantly different and ranged from 987 kg DM/ha (Zulumax arrow leaf clover) to 1622 (Turbo Persian clover). Their nutritive value did vary significantly (P < 0.05) with the species generally ranked from highest value: Haifa white clover, Turbo Persian clover then Zulumax arrow leaf clover. Haifa white clover (both sowing methods) had significantly higher CP (14.1-14.4%), ME (9.1-9.2 MJ/kg DM) and WSC levels (5.9-6.5%) and significantly lower NDF concentration (48.7-50.2%).

Table 4. Nutritive value of legumes sown at 'Glen Oak' and 'Bonnington' (averaged over both sites). Neutral detergent fibre (NDF, %), crude protein (CP, %), metabolisable energy (ME, MJ/kg DM) and water soluble carbohydrate (WSC, %) were analysed on samples collected in October and December 2015.

	October 2015				December 2015			
Legume	CP (%)	ME (MJ/ kgDM)	WSC (%)	NDF (%)	CP (%)	ME (MJ/ kgDM)	WSC (%)	NDF (%)
Arrow leaf	18.3	11.0	10.9	41.8	8.8	7.4	2.0	56.3
Balansa clover cv. Cobra	15.9	10.2	5.2	43.8	-	-	-	-
Bladder clover cv. Bartolo	20.1	11.3	11.5	38.2	-	-	-	-
Gland clover cv. Prima	13.7	9.3	4.4	48.3	-	-	-	-
Gland clover cv. Prima-BC[1]	13.3	9.5	6.9	47.2	-	-	-	-
Persian clover	20.7	11.1	6.9	39.0	12.0	8.1	2.0	53.5
Spineless burr medic cv. Cavalier	15.3	10.4	14.0	42.7	-	-	-	-
Subterranean clover cv. Antas	16.9	10.3	5.4	46.0	-	-	-	-
Subterranean clover cv. Antas-BC	16.1	10.1	5.8	47.0	-	-	-	-
Subterranean clover cv. Clare	16.5	10.4	7.0	46.7	-	-	-	-
White clover cv. Haifa	19.9	10.7	6.6	39.7	14.4	9.2	6.5	48.7
White clover cv. Haifa-BC	19.3	10.6	7.1	39.2	14.1	9.1	5.9	50.2
lsd (P = 0.05)	2.00	0.52	2.69	3.12	1.74	0.39	1.95	3.02

[1]BC = broadcast sown

4.1.4 Tropical grass evaluation (Trial 7) 'Bonhomie'

The site was highly variable with higher productivity evident in the down slope replicate than in the upper slope replicate. All grasses established except Blue Dawn Brunswick grass. Solander Setaria had the highest herbage mass (8604 kg DM/ha, P < 0.05), but was similar to Narok Setaria, Megamax 059 panic grass, and Callide and Katambora Rhodes grasses (Table 5). Sabi grass was the least productive grass (391 kg DM/ha, P < 0.05) of those that established, although similar to seven other grasses.

Both kikuyu cultivars had the highest ME and CP of the grasses, averaging 11.1 MJ/kg DM and 13.1% respectively (P < 0.05, Table 4). All grasses had ME values greater than 9 MJ/kg DM (suitable for

moderate animal production). Crude protein values were more varied, falling as low as 4.1% for Gatton panic, which was not significantly different to both Setaria cultivars and Katambora Rhodes grass and Megamax 059 panic grass. Crude protein at this level is likely to limit the efficiency with which cattle will digest these grasses. Once the best of the leaf has been grazed off it is likely that animals may require protein supplements or urea lick if the remaining biomass is to be fully utilised.

Table 5. Herbage mass (kg DM/ha), metabolisable energy (MJ/kg DM) and crude protein (%) at 'Bonhomie' on April 2017.

	Herbage mass (kg DM/ha)	Metabolisable energy (MJ/kg DM)	Crude protein (%)
Brunswick grass cv. Blue Dawn	–[1]	–[1]	–[1]
Kikuyu cv. Acacia	1671	11.1	13.0
Kikuyu cv. Whittet	2836	11.0	13.1
Panic grass cv. Gatton	3200	9.5	4.1
Panic grass cv. Megamax 059	6089	9.2	5.8
Rhodes grass cv. Callide	4124	9.6	9.2
Rhodes grass cv. Katambora	4036	9.4	7.9
Rhodes grass cv. Toro	2836	10.2	9.2
Sabi grass	391	10.4	8.6
Setaria cv. Narok	7236	9.2	6.4
Setaria cv. Solander	8604	9.1	6.0
lsd (P = 0.05)	4813.8	0.81	4.0

[1]Did not establish

4.2 Extension and communication

Extension activities gained extensive contact with the local farming community and their service providers. Both on site field days were tremendously successful with 60 people attending the legume trials in October 2015 and 50 attending the subtropical grass trials in May 2016.

Table 6. Extension and communication activities conducted throughout the project

Date	Location	Activity	Number in Attendance
August 2014	Mailing Lists	Newsletter 1	70 including producers – email list total of 40 producers plus 30 interested others, seed distributors, rural suppliers, Singleton Land & Beef Group, Barrington Beef Group
October 2014	Beddingdown	Farm Pasture Trial Walk. Site inspection and discussions	26 beef producers – email distribution, ad in Dungog Chronicle (Town & Country Magazine)
October 2014	Tocal Ag College, Paterson	Grassland Society of NSW Pasture Update	Power Point presentation and talk to 60 plus people.
December 2014	Tocal Ag College	Annual Meeting	10 group members, Researcher DPI and State Co-ordinator
May 2015	Gresford Recreation Club	Dungog – Gresford Land & Beef Hoof & Hook Dinner	72 people
April 2015	Mailing Lists	Newsletter 2	70 including producers – email list total of 40 producers plus 30 interested others, seed distributors, rural suppliers, Singleton Land & Beef Group, Barrington Beef Group

September 2015	Town & Country Magazine	Field Day advertisement & press release	
October 2015	Oakendale & Bonnington	Field Day on Legume Trials	59 people – 49 producers, 2 Agric consultants, 3 seed distributors, 2 DPI & 1 Project Co-ordinator, 2 ag students.
December 2015	Bonnington	Annual Meeting	11 group members, State Co-ordinator, Researcher DPI.
April 2016	Dungog RSL Club	Dungog – Gresford Land & Beef Hoof & Hook Dinner	Power Point presentation and talk to 71 people – 48 beef producers, 2 rural bankers, 2 industry suppliers, 4 industry support and 6 guests of producers.
May 2016	Bonnington	Field Day Grasses	49 in attendance – 39 beef producers, 6 agronomist, 2 NSW DPI officers, 2 LLS officers
June 2016		Newsletter 3	70 including producers - email list total of 40 producers plus 30 interested others, seed distributors, rural suppliers, Singleton Land & Beef Group, Barrington Beef Group
July 2016	Beddingdown	Trial site inspection & discussions on feed analysis results	15 producers, 1 DPI NSW
December 2016	Oakendale	Annual meeting	11 group members and State Co-ordinator, DPI Researcher.
April 2017	Gresford Recreation Club	Dungog – Gresford Land & Beef Hoof & Hook Dinner	75 people in attendance – power point presentation and talk.
May 2017	Tocal Ag College, Paterson	Grassland Society of NSW Pasture Update	65 people in attendance – beef producers, Grassland Society members, DPI, LLS and MLA staff. Power point presentation and talk.

4.3 Participant reactions

4.3.1 Research skills

The purpose of the project was to trial pasture species new to the district that could potentially increase production, and allow interested producers to see first-hand the relevence of the species to their individual requirements. In addition, the project sought to clarify the groups uncertainty as to the best establishment techniques for new pasture.

The project also identified that, despite the wide variety of soil types and growing conditions on individual farms within the area, all could be grouped into either high or low soil fertility sites to successfully describe most situations.

Importantly, the DGLB group had never been involved in running pasture trials before, and as a result of this three year project, the group has learnt a lot about conducting research and interpreting trial results, and have also increased knowledge of new pasture varieties and sowing methods. As a result, this has changed the member attitudes, with producers increasingly interested in improving pastures and some have already commenced largescale plantings of some of the trialed

varieties that performed well in their particular landtype - and adjusted sowing techniques to suit seasonal conditions.

Group members are now quite proficient in establishing and managing simple pasture trials which is major change. Skills have been developed in trial layout, assessment, sample handling, feed testing and interpreting records. Importantly the group is keen to continue observations on some of the later sown trial beyond the official end of this project.

4.3.2 On farm impacts

As a result of the project, producer members of the DGLB and farmers who have followed the trials via field days, newsletters and discussions with DGLB members have sown commercial areas using knowledge from the trials. Examples include:

Producer (Initials)	Practice Change / commercial adoption
WO	Sowed Prima gland and Antas sub clover on lower slopes
GH	Sowed Balansa instead of traditionally sowing Haifa white
MB	Sowed Antas sub clover on ridge country
PL	Sowed Solander Setaria on a large area of low fertility hill country
RK	Broadcast Narok Setaria and Callide Rhodes on low fertility
SD	Sowed Solander Setaria as an alternate to kikuyu
JB	Sowed Arrow leaf over large area
MT	Sowed Solander Setaria and Katambora Rhodes grass on low fertility soils.

4.4 Producer Research Site program

The group stayed with the overall topic to research new varieties and sowing methods for this district, however many changes to the original work plan were needed due to weather conditions (too wet /too dry), which impacted on sowing times and scheduled trial cuts and assessments. The group was also required to change the site location for Trial 4 because the original site was ultimately unsuitable.

In the second round of legume and grass trials the group amended the workplan, and used the best performing species from the first round of trials and added new species and varieties for testing which were unavailable at the first round of sowing. Changes were also made to the overall research plan due to weather conditions which had an ultimate impact on the trials. This meant the group wasunable to achieve the initial planned number of pasture assessments and preferred planting times of trials.

5 Discussion

5.1 General observations

5.1.1 Temperate legumes

White clover was the standout legume in all of the groups experiments. White clover is a perennial, however in this region it tends to act as an annual species, so long term persistence depends on maintaining a large residual seed bank to ensure sufficient seed for regeneration in the next favourable season.

The newer, alternative annual legumes that performed well in these trials warrant further investigation, with exploratory inclusion in legumes mixes already being undertaken by local producers. These alternative legumes include, Santorini yellow serradella, Prima gland clover, Balansa and Persian clover.

Subterranean clover performance was mixed. The cultivars tested were from the subspecies *Subterraneum* and *Brachycalycinum* which are suited to acid-neutral and neutral-alkaline soils respectively. The mixed performance of the sub clovers during the trials demonstrated the value of evaluating a range of cultivars, over multiple years, because the variation between trial site/time demonstrated to producers the impact of seasonal conditions (good rainfall cf.poor rainfall).

Direct drilling is recommended to provide good seed-soil contact and improve establishment of legumes, but is not always possible. The research showed that broadcasting seed can be as effective as direct drilling in a good season. Identifying these seasons without the advantage of hindsight is the challenge. Management of competition from existing pasture is critical - no matter which sowing method was used. Existing pasture must be removed by heavy grazing, plus slashing if necessary. The use of glyphosate herbicide was mostly very beneficial, with application rates and timing dependent on the existing pasture species on site - and the seasonal conditions at the time of application.

5.1.2 Tropical grasses

The main tropical grasses sown in the region are kikuyu, Setaria, and Rhodes grass, with common paspalum naturalised in many pastures. The research showed that Setaria and Rhodes grass are productive grasses, but also highlighted the new panic grass cultivar, Megamax 059, equally productive in our region. Local experience has shown kikuyu to be only productive on the more fertile soils. It also offers the advantage of not producing the bulk of dry matter in stem and seed head as other grasses do (which is reflected in lower herbage production), but this also gives advantage in feed quality (ME). The challenge for producers utilising Setaria, Rhodes grass and Panic pastures is to achieve grazing pressure at a rate that ensures a high leaf to stem ratio is maintained - and thus better feed quality.

5.2 Outcomes in achieving objectives

5.2.1 Objective 1: Evaluate the potential for a range of new legume species to be established in existing C4 grass pastures on both high and low fertility soils.

Four legume trials were established (two on high fertility and two on low fertility soils) involving 15 varieties. All legumes germinated, however some established and grew better than others. Soil fertility did not impact germination and establishment on the sites possibly because all sites were sown with fertiliser. The best growth and production was achieved from the control Haifa white clover, sub clovers and the gland clover. The Haifa white clover appeared to be most persistent and dominated trials in years two and three.

Novel legumes including Bladder, Serradella and Biserrula germinated and grew in year one of trials, but were not as productive or persistent as the more successful varieties. In the second round of legume trials (trials 4 and 5) good growth was seen from Persian, Balansa and Arrow leaf. Cavalier medic did not grow as well as others. It should be noted that these trials were favoured by a long wet spring which suited late maturing varieties Persian, Arrow leaf and Haifa. Although all varieties set seed it was the Haifa white clover which appeared to regenerate best the following year.

5.2.2 Objective 2: Evaluate the potential of broadcasting methods to establish legumes into existing tropical pastures compared to direct drilling.

Trials 1 and 2 were set up in such a way as to observe the effect of spraying with glyphosate herbicide compared to no spray. In these trials pasture knocked down with herbicide made an obvious difference with much better establishment in the sprayed areas at both sites (kikuyu or naturalised carpet grass and paspalum). Both trials were sown by direct drill.

Trials 4 and 5 compared direct drilling with broadcasting, with observations again on spray and non-spray. These trials were sown late in a wet year and sowing method did not have a significant effect.

Observations from the four trials over two different years demonstrated the importance of using an appropriate paddock preparation and sowing method to suit the seasonal conditions. In a dry year, spraying made a difference and direct drilling is expected to have advantage. In a wet year, broadcasting seed was equally effective as direct drilling.

Grazing management prior to sowing also influenced the results of direct drilling versus broadcast and germination and establishment of legumes, as shown by the move of trials from Beddingdown to Oakendale site (heavy grazing at Beddingdown appeared to allow germination of white clover in kikuyu pasture).

5.2.3 Objective 3:Evaluate the production and quality of pastures that include novel legumes compared to the current district practice (white clover) and the site baseline of no legume.

White clover (Haifa) proved to be more reliable than other legumes been trialled. It grew as well as the best of the other species, and was able to regenerate better than the other legumes tested in the trials. White clover dominated the trial sites in years two and three.

Feed quality results confirmed all legumes were of high quality with only minor variation between varieties at similar growth stage. Feed value declined with maturity in varieties which developed a large stem, including Arrow leaf and Persian. Quality also declined in late spring coinciding with hot weather, which also coincided with development of stem and increasing maturity. Being a perennial species, White clover was able to maintain vegetative growth longer through the growing season, hence green feed of high quality was maintained right into the summer when most temperate annual species had senesced.

5.2.4 Objective 4: Evaluate the potential of a range of improved tropical grass species to replace low quality pastures on low fertility soils.

A range of tropical grasses were sown in Trial 3 with Setaria and Rhodes grass being the most successful for both establishment and growth at the low soil fertility site. Additional Trials 6 and 7 were sown to compare several Rhodes grass and Setaria varieties with additional tropical grasses Panic, Sabi and kikuyu. Trials 6 and 7 were sown under very dry conditions, Trial 6 at the low fertility site failed to establish due to extreme prolonged dry. Trial 7 did establish with rain in February (three months after sowing). All grasses grew well with Setarias and Panics outstanding. Feed quality reflected leaf to stem ratio with kikuyu having the highest quality followed by Rhodes grass, Panic and Setaria. Panic and Setaria with large stems would be expected to have higher feed quality when managed to maintain a high proportion of leaf i.e. graze earlier.

Trial 6 and 7 were sown toward the end of this project and will continue to be monitored informally by the group in future.

5.3 Outcomes summary

Project objective	Outcome
1. Evaluate the potential for a range of new legume species to be established in existing C4 grass pastures on both high and low fertility soils.	Many of the new legume species established well in the year of sowing however only Haifa white clover and the two sub clovers persisted in the second year on the low fertility "Bonnington" site. The same three in addition to yellow serradella persisted and produced biomass in the second year on the higher fertility site at "Beddingdown". It is likely that the traditional clovers are still the best choice of the temperate legumes and that soil fertility management is the key to ongoing persistence and production.
2. Evaluate the potential of broadcasting methods to establish legumes into existing tropical pastures compared to direct drilling	In the year of the trial the method of establishment (drilled vs broadcast) did not make a difference to the establishment of the three species tested however the treatment with a "knockdown" herbicide prior to sowing proved pivotal in the establishment of all varieties. There was negligible establishment of legumes into established pasture on Trials 1, 2, 3 and 4 without presowing herbicide treatment.
3. Evaluate the production and quality of pastures that include novel legumes compared to the current district practice (white clover) and the site baseline of no legume.	White clover proved to be the equal of the best novel legumes for biomass production over spring but was also able to maintain growth for longer into the summer. It was also among the highest species for feed value which was again maintained longer through the season. Use of appropriate fertiliser rates in the trial compared to common district practise is likely to be the main reason for non-performance of white clover on group member's farms in the past.
4. **:** Evaluate the potential of a range of improved tropical grass species to replace low quality pastures on low fertility soils.	Cultivars of Setaria and Rhodes grass established the best and gave the highest biomass production at the low fertility "Bonnington" site. When trialled on the higher fertility site of "Bonhomie" again the Setaria and Rhodes grasses performed well in addition to the Megamax 059 Panic. Even though not producing as much biomass as the Setaria the Kikuyu varieties trialled were able to produce much higher average quality of forage reflecting the shorter growth habit and much higher leaf to

	stem ratios. Overall the best performing varieties of Setaria and Rhodes grass will prove useful in improving production on lower fertility hill country and once established should help exclude weedy species such as blady grass.

5.4 The value of the research results (Benefits/Costs)

It is too early to put an accurate cost benefit on the project. However, the trial results indicate that establishing improved subtropical grass pastures and legumes would significantly increase pasture production for the group. Initial observations from group members indicate that production could increase between two and four fold over current levels.

For example, given the DGLB has 45 active members, with 10640 head of cattle on 15200 ha. If a 1000 ha were pasture improved increased production could be worth $700,000 a year to the group (average 0.7 head/ha (10000 head /15000ha) x 1000 ha = 700 head x $1000). If this technology is adopted by other producers in the area this number could easily double. Noting that individual producers will choose varieties and establishment techniques to suit their situation in regard to topography, soil type and fertility.

The project has also strengthened relationships within the group as demonstrated by strong attendance at all events. The project has also built a relationship between the group and MLA. Feedback from producers outside of the group and industry representatives including seed companies has been very positive following field days and seminars.

5.5 Promotion of research results and its effectiveness

The group continues to encourage new members and participants to the group, and the events it organsies. As detailed earlier in this report a total of 532 attended events. The mix of field days and presentations seems to have been successful along with individual contacts as we talk to people informally. The sound level of response from around the region, and ultimate success of the events organised during the three years of trials, was above expectation.

At the end of the project producers are trying new pasture mixes as illustrated in section 4.3.2. There is an increase in interest in pasture improvement as a result of the project supported by positive financial returns from cattle. Seasonal conditions had a major impact on the project especially sourcing seed (tropical grass seed availability severally impacted by Queensland drought) and when sowing. Very dry conditions prevailed at sowing time in 2014 and 2016 while very wet conditions (Dungog Superstorm/ East Coast Low) prevailed in 2015.

5.6 Effectiveness of the participatory research process

The DGLB is a well established group with a long history of working together. The PRS concept was a very new experience for group members, but the group was engaged right from the start and the objectives were relevant to members.

When a commitment was made to undertake the project (contract signed), DGLB took their obligation very seriously and the outcome was very successful.

The group have appreciated the rigor associated with the conduct of research and now have a much better understanding of the need for replication of treatments as well as controls for comparison as well as methods to use to evaluate pasture production. Funding from MLA for the PRS was an essential enabler for the project to go ahead.

The following are comments from group members which highlight there engagement in the PRS process and the value they have derived from it.

"The legume and grass trial conducted by the Dungog – Gresford Land & Beef group has been very helpful in selecting species of plants that I have subsequently planted on my property. I intend to further use certain species, particularly some in the tropical grasses trialled, to further improve the less developed areas of the property".

Murray Brooker

"Some of the tropical grasses trialled by the Dungog – Gresford Land & Beef group have proven themselves to be viable alternatives to kikuyu in our district on both higher and low fertility soils. I have and will continue on trialling them on a larger scale on my property".

Suellen Dunlop

"The legume and grasses trials carried out by the Dungog – Gresford Land & Beef group over the past three years have proved to be valuable for producers in this district. After struggling severe weather conditions the grasses trial on "Bonhomie" proved to be a success and we intend sowing some of these grasses on our property into the future."

Robert & Marilyn Flannery

"The MLA funded project carried out by the Dungog – Gresford Land & Beef has allowed new legumes and tropical grasses to our area to be trialled which as producers we would not have been able to do on our own. We have planted some legumes on our property and are planning on trialling some grasses"

Geoff & Nerelle Hand.

"As a member of the Dungog – Gresford Land & Beef group I have found the group's participation in the pasture trial very valuable to our operation. It has encouraged me to take a look at the grasses we use and particularly the use of legumes"

Julia Wokes

The Dungog Gresford Land & Beef legume and subtropical grasses trials proved what can be achieved with deep rooted perennials under very adverse conditions.

As a result of the observed responses we have seeded about 50 acres of bare ground, new dam banks and treated blady grass areas with a mixture of Setaria Solander and Callide Rhodes grasses with a fair amount of success in droughty weather, providing very little useful moisture during the

growing period. It is interesting to see healthy clovers like Arrowleaf appearing sporadically in another paddock a kilometre from the trial.

Rod Kater

The group has more follow up questions around use of fertilisers and grazing management to successfully establish and manage tropical grass based pastures. A larger area is needed to incorporate all aspects of commercial beef production. For example tropical grass based pasture on a larger area to allow cattle weight gains to be recorded and more realistic costs benefits to be realistic. Another aspect of managing tropical grassed based pastures is the use of hay and silage to manage seasonal surpluses and deficiencies.

6 Conclusions/Key messages/Recommendations

- After trying a wide range of pasture legumes it was found that Haifa white clover preformed better than the others. Improved management is the key to more productive and persistent legumes rather than looking to new species in the area.

- On high fertility soils kikuyu is well adapted within the region. In these situations the main aim is to fill the winter feed gap possibly using white clover. Further work could investigate management to allow persistence of annual rye grass to further assist with winter production in kikuyu swards.

- On lower fertility soils trials showed that Setaria and Rhodes grass can grow well and have potential to greatly increase pasture production. The challenge now is to develop a total management package including fertiliser and grazing management to gain the full benefit of these grasses.

- Further investigation is warranted to determine the place of Setaria, Panic and Rhodes on higher fertility soils as an alternate to kikuyu.

- DGLB is a strong group that worked well together over the project, with individuals displaying various strengths i.e. photography, presentations, trial work and tractor work. Collectively the group demonstrated flexibility to cope with unexpected situations and changes to the project workplan.

- Lack of experience in preparation of technical reports hinders the ability of farmer groups to complete them. It may be useful to provide training in this area although difficult to administer due to nature of farming members.

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8 Appendix

8.1 Acknowledgements

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