final report

Project code:	B.NBP.0600 (PDS 6)
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Date published:	October 2015
ISBN:	9781741919882

PUBLISHED BY
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Locked Bag 991
NORTH SYDNEY NSW 2059

The economic performance of beef cattle finishing systems used on the North-Eastern Downs

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

Abstract

Producers finish cattle using different systems, but which are profitable? A PDS at 'Bannockburn' near Bell in Queensland evaluated the economics of finishing systems encompassing sown grass-only pastures, leucaena-grass, forage oats and feedlotting. Two mobs of EU steers (350 kg entry liveweight) were assessed, 87 head in 2011 and 100 head in 2012. Three-quarters of each mob grazed leucaena-grass for six months until June and then split onto oats, into the feedlot or onto leucaena-grass. The remaining steers grazed grass-only for the entire period. Steers were weighed six times, faecal samples were collected monthly to determine diet quality and stocking rates were monitored continuously. Systems were compared on the partial return on livestock capital invested. The high-input systems (leucaena, oats and feedlot) produced significantly higher annual returns than the grass-only system both years. The kilograms of liveweight produced per hectare in the leucaena-grass finishing system was double that of the grass-only. Approximately 200 people attended three field days run in conjunction with this PDS and 11 businesses attended workshop training days. Feedback from these events suggested that the objective data from the demonstration created awareness and prompted practice change.

Executive summary

Producers on the North-Eastern Downs of southern Queensland have the unique opportunity to use many different systems to finish cattle; however there is little knowledge regarding their profitability. A three-year Producer Demonstration Site (PDS) at 'Bannockburn' near Bell commenced in late 2010 and evaluated the economic performance of beef cattle finishing systems encompassing sown grass-only pastures, leucaena-grass, forage oats and feedlotting. Two mobs of EU (non-hormone growth promotant) steers with an approximate 350 kg entry liveweight were assessed, 87 head in 2011 and 100 head in 2012. Approximately three-quarters of each mob initially grazed Cunningham leucaena-grass pastures (predominantly frost-free) for six months up until June, at which point the group was split three ways onto Drover oats, into the on-farm feedlot and back onto leucaena-grass. The remainder of the steers grazed grass-only (Bambatsi, Gatton Panic, creeping bluegrass and Rhodes) paddocks for the entire annual trial period. The steers were weighed six times throughout each trial period and faecal samples were collected monthly for analysis using faecal near infrared reflectance spectroscopy (F.NIRS) to determine diet quality. Stocking rates were monitored continuously. Each system was compared on the partial return on livestock capital invested for two periods, prior to and after June, and annually. Property owners, Ranald and Sally Ferrier, and property manager, Steve Munge, were the host co-operators for the PDS, however 14 other businesses made up the core producer group that provided input into the PDS and regularly attended activities.

The 2011 results are based on a 364 day period and the 2012 results on a 320 day period. The average daily gain on leucaena-grass was approximately 0.7 kg/hd/day for both years, whereas grass-only produced 0.58 kg/hd/day and 0.48 kg/hd/day in 2011 and 2012 respectively. Steers grazing leucaena-grass displayed a greater range in average daily gain compared to those steers on grass-only, which is supported by McLennan (2014). However, over the summer, the steer weight gains were similar on leucaena-grass and grass-only. This has enabled the property manager to make more informed decisions regarding the use of grass-only paddocks if required over summer, as part of a rotation strategy to rest the leucaena-grass without sacrificing weight gain. During winter, steers on grass-only lost on average 0.25 kg/hd/day in both years, whereas the steers on leucaena-grass gained weight (0.1 kg/hd/day in 2011 and 0.56 kg/hd/day in 2012). F.NIRS results for crude protein (CP) and dry matter digestibility (DMD) suggest reasons for this difference in weight gains. Generally, the CP and DMD levels were higher for leucaena-grass than grass-only over the course of the two years, and the rise and fall of these levels was reflected in the change in weight gains. Steers in the feedlot achieved just over 1.5 kg/hd/day consistently and the steers on oats averaged 0.77 kg/hd/day in 2011 and 0.91 kg/hd/day in 2012.

The stocking rate on leucaena-grass for 2011 and 2012 was 1 hectare per head (ha/hd) and 1.3 ha/hd respectively, whereas the grass-only was stocked at 1.68ha/hd and 2.01 ha/hd. All trial paddocks were in good land condition at the start and end of the project. Steers grazing leucaena-grass year-round produced more than double the kilograms of liveweight per hectare (kg/ha) compared to those on grass-only (252kg/ha vs 125 kg/ha in 2011 and 179 kg/ha vs 76 kg/ha in 2012). These kg/ha differences are supported by the findings of Bowen et al. (2015). This result was considered by many producers to be a key finding of the PDS.

The partial return on livestock capital invested examined the value added by the steers less the variable costs, but not all overheads. The analysis considered the opportunity cost of the steer capital, pasture development and land capital, along with the costs of labour, treatments, feeding and selling. The economic performance of the four main finishing systems analysed across both annual trial periods is shown in Table 1. In 2012, economic analysis was conducted for two additional systems involving steers grazing grass for either

six months or 320 days before entering the feedlot. The economics of grain bin feeding post the annual trial period was also analysed.

Table 1: Partial return on livestock capital invested in the four main finishing systems, 2011–2012

1st period return			2nd period return			Annual return	
	2011	2012		2011	2012	2011	2012
Leucaena-grass	19%	9%	Leucaena-grass	6%	6%	26%	18%
			Oats	3%	2%	22%	10%
			Feedlot	10%	13%	31%	23%
Grass-only	7%	7%	Grass-only	6%	-5%	14%	-1%

The high-input finishing systems (leucaena, oats and feedlot) produced significantly higher annual returns on the investment in livestock than the grass-only system in 2011 and 2012. The steers grazing leucaena-grass for six months and then finished in the on-farm feedlot produced the highest annual return. This was followed by steers that grazed leucaena-grass year-round, then steers that grazed leucaena-grass for six months and finished on oats. Steers that grazed grass-only for the entire trial period recorded the lowest return in both years. These results reflect the situation at 'Bannockburn' in 2011 and 2012 and were dependent on many factors including rainfall, cattle performance, mob size, cattle prices and grain prices.

Using radio frequency identification device (RFID) numbers and records, individual animal returns were investigated. The producer group wanted to know how well leucaena-grass and grass-only steers performed within their group in the first period (up until June) and then from an annual return perspective. In 2011, of the 20% of bottom performing steers on leucaena-grass after period one, 80% remained bottom performers when evaluated on an annual return basis. This suggests an opportunity exists to remove less profitable animals from the system in June, instead of carrying them through to the end of the year.

Results of the PDS have been widely disseminated through media, forums and field days with positive feedback received. The information derived from this project has provided the co-operators and producers in the region with objective data on the selected finishing systems, assisting them in making more informed business and land allocation decisions, and ultimately leading to increased profitability and sustainability. On-farm practice change has occurred both at 'Bannockburn' and on more than half of the other 14 producer group members' properties. At 'Bannockburn', leucaena now has a pivotal role in backgrounding large steer numbers for their feedlot and not finishing. No steers graze grass-only paddocks during winter and the feedlot is now being used as an end point for all cattle. Two nearby producers, as a result of witnessing the performance of leucaena at 'Bannockburn', have planted new stands of leucaena over the 2014/2015 summer.

Further research is recommended to gain a better understanding of why there is such variation in the performance of individual animals within different finishing systems. A better understanding would allow decisions on the allocation of animals to particular finishing systems to be made, thereby reducing financial risk and enabling more opportunity for financial benefit for producers.

Table of Contents

1 Background

An assessment of the northern Australian beef industry in 2013 concluded that the profitability of beef businesses is generally low and the majority of businesses are considered economically unsustainable (McLean et al. 2014). In the face of the cost-price squeeze, producers are constantly looking for ways to boost their on-farm profitability, mainly through increasing the liveweight gain of stock, at minimal cost. In support of this, it is suggested that to enhance long-term viability, it is imperative to improve financial literacy and debt management, understand profit drivers, focus on increasing income, improve climate risk management, manage expenses and match stocking rates to the long-term carrying capacity (McLean et al. 2014).

Producers also want a premium for their product, with many targeting high value markets such as European Union (EU), Meat Standards Australia (MSA) and Pasturefed Cattle Assurance Scheme (PCAS). These markets tend to favour younger cattle that have had good nutrition throughout their lives. A number of producers are now meeting these market specifications by using a range of finishing systems, but what is it costing them to do so and how do these different systems compare? In many cases, this assessment is unknown and hence was the basis for this Producer Demonstration Site (PDS).

Traditionally in southern Queensland, grass-fed systems have been used to fatten cattle, however, a winter feed gap can eventuate with the incidence of frosts, and maintaining liveweight gain is a challenge. Forage oats can fill the gap, but requires additional labour and machinery and is often considered risky given the need for in-crop rain. Alternatively, some producers feed grain to keep cattle gaining weight.

In central and north Queensland, leucaena, a high protein tree legume, provides additional production, but its susceptibility to cooler temperatures is thought to limit its value in southern Queensland. Despite this, in the last decade near Bell on the North-Eastern Darling Downs, approximately eight businesses have established stands of leucaena. A similar number have invested in on-farm feedlots.

The host property for this PDS, ‘Bannockburn’ near Bell, is owned by Ranald and Sally Ferrier of Roma, and has both leucaena and an on-farm feedlot established. The business also uses oats in the winter and sown grass-only pastures have replaced the majority of native pastures. The Ferriers live at ‘Nareeten’ Roma, where they breed and background Angus and Euro-cross cattle, but in the early 2000s they decided to expand their business by purchasing land in the Bell district. Gradually they acquired more land and the property today, ‘Bannockburn’, formerly known as ‘Bonnie Doon’, is now 1300 hectares of good quality soil (vine scrub to heavier alluvial black soil flats) consisting of 770 ha of cultivation, 200 ha of leucaena-grass pastures and 325 ha of sown grass-only pastures.

1.1 Host property history

Initially, ‘Bannockburn’ was less than half the size it is today and consisted predominantly of old cultivation, which was planted to oats for fattening cattle. Realising that the old cultivation was becoming uneconomical due to the need for too much overlapping, the owners changed land use and on-farm practices. Steve Munge commenced managing the property in the mid-2000s and assisted in the transition from traditional ploughing of paddocks to zero-till farming. Leucaena was also investigated as an alternative land use. After several property visits and discussions with people already using leucaena in southern Queensland, the Ferriers decided to invest in a leucaena planter and commenced planting 100 acres of the Cunningham variety at six metre centre spacings in the summer of 2006/07, applying Starter Z fertilizer in the beginning. A pasture mix of Bambatsi, Gatton Panic, creeping bluegrass and Rhodes was planted in between the rows in 2007. In later leucaena stands, eight metre

centre spacings were adopted. Between 2005 and 2009, several old cultivation paddocks, including our grass-only demonstration paddocks, were sown to the same pasture mix as that in the leucaena stands, however Bambatsi and Gatton Panic formed the bulk of the mix. In most instances, approximately 100kg urea per hectare was applied. A 500 head feedlot was built in 2006, and as a result, the cultivation is now mainly used for growing wheat, sorghum and silage, with some forage oats still being grown.

1.2 Evolution of the PDS

After reading an article about the indeterminate performance of leucaena in southern Queensland, the Ferriers questioned the livestock and economic performance of their finishing options. They approached the Department of Agriculture and Fisheries (DAF) in 2010 with the concept of testing the economics of their different finishing systems. A PDS was established in consultation with a local producer group, with the findings shared with the wider beef industry through field days and media articles.

2 Project objectives

1. Measure the production (liveweight gain) of animals involved in five finishing systems, focusing on meeting market specifications efficiently and cost-effectively. The finishing systems include:

    1. Leucaena-grass pastures for 12 months

    2. Leucaena-grass pastures until the end of May and finished on oats for approximately 100 days

    3. Leucaena-grass pastures until the end of May and finished in the on-farm feedlot

    4. Grass pastures (control) for 12 months and finished in the on-farm feedlot (first mob of cattle)

    5. Grass pastures (control) for 12 months and finished on leucaena-grass pastures (second mob of cattle).

2. Determine the relative economic performance of the different production systems.

3. Investigate with producers how matching stocking rates to long-term carrying capacity maximises liveweight gain and maintains a healthy, productive grazing resource.

4. Demonstrate the value of record-keeping to monitor performance and compare different management options.

5. Communicate the results and learnings of the demonstration to a broad range of stakeholders in the region through field days and media releases.

N.B. Finishing systems four and five were modified during the project due to property management decisions and in order for the steers to meet market specifications. The actual systems investigated in 2011 and 2012 are explained in Section 3 (Method).

3 Method

3.1 Project design

The project commenced in November 2010 and finished in November 2013. It evaluated different finishing systems that encompassed sown grass-only pasture, leucaena-grass, oats and lot feeding. Two purchased mobs of EU (non-hormone growth promotant) steers averaging approximately 350 kg entry liveweight were monitored, 87 head over a 364-day period in 2011 and 100 head over 320 days in 2012. The first mob of crossbred steers monitored in 2011 were purchased from a single vendor at the Roma saleyards and were of higher content Charolais, Angus and Shorthorn. The steers monitored in 2012 came from two vendors, of which one had predominantly Angus cross and the other Simmental cross (Appendix 1).

The Charolais, Angus and Shorthorn steers were evenly allocated across the four finishing systems (treatment groups) in 2011, as were the steers from the two different vendors in 2012. Liveweights were stratified prior to treatment allocation ensuring that at the start of each trial year, the average weight of each treatment group was within 10 kg of each other.

3.1.1 Finishing systems

The finishing systems outlined in the original project objectives were adjusted during the project due to property management decisions. The length of each annual trial period (364 days in 2011 and 320 days in 2012) was also a variation on the original proposal. The 2012 trial period was 44 days less due to the well-below average rainfall in the latter part of that year, and resultant management decisions. The four main finishing systems analysed in 2011 and 2012 were:

1. Leucaena: Leucaena-grass pastures

2. Oats: Leucaena-grass pastures until the end of May and then finished on oats for approximately 100 days

3. Feedlot: Leucaena-grass pastures until the end of May and then finished in on-farm feedlot

4. Grass-only: sown grass pastures

In 2012, two additional systems were assessed:

5. Grass-only pastures until the end of May and then finished in on-farm feedlot

6. Grass-only pastures for the annual trial period and then finished in on-farm feedlot with an HGP

The steers were generally sold as finished animals when they were likely to be over 320 kg carcase weight (average dressing percentage of 54%) and perceived to have more than 12 mm of fat at the P8 site. Steers not meeting market specifications at the end of the annual trial period were placed on a grain bin and the economics of this additional system component was also assessed.

Figure 1 shows the flow of steers through the various finishing systems in 2011. The grass-only cattle remained on grass (Bambatsi, Gatton Panic, creeping bluegrass and Rhodes) for the entire annual trial period of 364 days. The leucaena, oats, feedlot treatment groups were

initially run as one group on predominantly frost-free leucaena-grass pastures for six months up until June, at which point they were split into their treatment allocations.

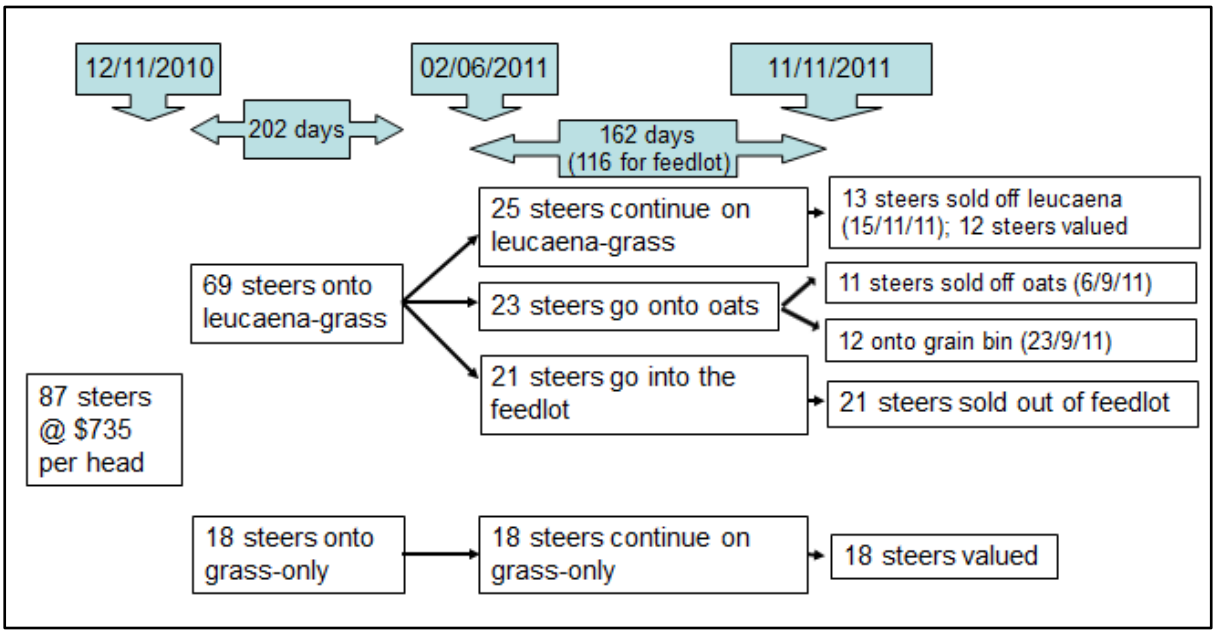


Figure 1: Schematic showing the number of steers allocated to each finishing system in 2011.

The flow of steers through the four main finishing systems, along with the two additional finishing systems in 2012, is shown in Figure 2.

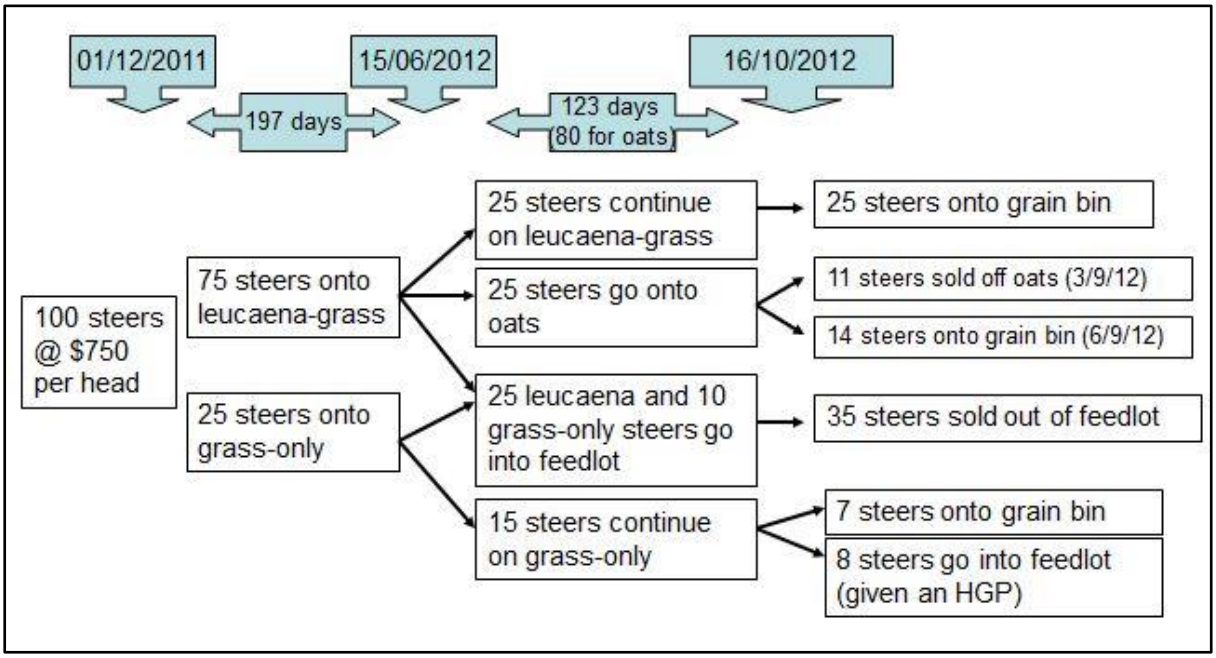


Figure 2: Schematic showing the number of steers allocated to each finishing system in 2012.

3.2 Animal identification and measurements

Individual identification was used to monitor the change in liveweight of individual animals and treatment groups throughout the demonstration. On arrival at the property, trial cattle had a National Livestock Identification System (NLIS) tag which contains a Radio Frequency Identification Device (RFID) number. On induction, steers received a pink management tag displaying the owner's name and an individual number. This number was entered into the

Tru-Test XR3000 indicator, along with the RFID number, with the aim of linking the two together to ensure that if one device fell out, the animals could still be identified. To more easily recognise animals in the paddocks and yards, steers were given an additional management tag of a certain colour, designating treatment group.

The steers were weighed six times each year, giving five average daily gain (ADG) figures with which to monitor fluctuations over the 12 months. They were weighed full each time immediately after mustering and not curfewed (removed) off feed and/or water for a length of time e.g. overnight. The final weight off leucaena-grass in June was used as the feedlot entry weight. The same weigh scales (load bars mounted beneath the vet crush) and indicator were used throughout the project for consistency.

The kilograms of liveweight produced per hectare (kg/ha) was calculated by adding up the total number of kilograms gained by all livestock that grazed the paddocks, divided by the area of the paddocks. The liveweight performance of any non-trial cattle that grazed in the paddocks was accounted for by assuming that they gained at the same rate as the trial cattle for the respective period in the paddock.

To determine if individual cattle remained consistently high or low weight gain performers, regardless of the feeding regime or time of year, in Microsoft Excel, steers were ranked within their treatment group for the first period from highest to lowest based on ADG. In a subsequent column, their second period ADG was recorded. A correlation was then devised using the Microsoft Excel formula = CORREL (column 1 wt. gains, column 2 wt. gains) to determine if the steers maintained their approximate ranking within the group across the two periods. In order to endorse the statement that there is consistently high and low weight gain performers, ideally the correlation figure would be greater than 0.7, meaning that the cattle maintained their ranking over 70% of the time.

3.3 Evaluating economic performance

The economic performance of each finishing system was compared annually and for two distinct periods, prior to June, when all steers were on either leucaena-grass or grass-only, and then from June onwards, when the steers had been placed into a treatment group.

The focus was on the relative profit of, or ‘value added’ by, the finishing systems, which is extra income minus the extra costs relevant to the comparison. This can be explained as the partial return on the livestock capital invested in the different systems. The partial return assesses the value added by the steers less the variable costs, but not all overheads.

The calculation of ‘value added’ is as follows:

	Closing steer value
minus	the opening steer value
equals	the gross value added to the steer
minus	the costs of holding the steer &
	the costs of feeding the steer
equals	the net value added to the steer

Costs have been apportioned to the various finishing systems according to their use. There are variables associated with the analysis, some known and others estimated based on the owner’s and manager’s experience and local knowledge. The results therefore relate directly to the circumstances of the demonstration and its period of operation. The known values include: opening weights and values of livestock, weight gains, feed consumed in the

feedlot, treatment costs, oats growing costs and sale values. The estimated values included: the value of the steers at the split-up weighing in June, the cost of labour, land, pasture development and capital equipment, the share of pasture eaten by the trial steers and the value of unsold steers at the end of the year (November in 2011 and October in 2012). For details see Appendices 6 and 7.

The purchase price of the steers was the actual price paid by the co-operator plus a 'freight in' cost. When steers were sent to the abattoir, their exit value from the system was determined by the actual price received (plus selling costs), which was influenced by carcase weight (CW) and compliance with market specifications. Given the relatively small treatment numbers in the trial, any animals that were significantly downgraded by >30c/kg CW were expected to skew the treatment results, thus these downgraded animals were given the average $/kg CW of that particular line of slaughter cattle. At the split-up weighing in June when cattle were not sold, and at the end of the trial period when some steers were not sent to the abattoir, a $/kg liveweight (LW) value had to be estimated based on the experience of the co-operator, the project team and other industry professionals. An opportunity cost of steer capital of 5% was used as that was the return that money would generate if invested in the bank in the short-term. For the opportunity cost of capital in the agricultural land, a realistic return of 3.5% was used.

The results from the PDS represent the circumstances at 'Bannockburn' during 2011 and 2012 and may not be readily transferable to different years or properties, without adjusting for local conditions.

3.4 Property management

Cattle were handled in the yards by both property and project staff in a quiet, safe and ethical manner. A quad bike and working dogs were used by property staff as per normal practice for moving cattle to and from the yards and between paddocks.

The property manager was responsible for determining when the steers were rotated between the leucaena-grass or grass-only paddocks. As the paddock sizes were all different, the length of time in each paddock also varied, however cattle were generally removed from a leucaena-grass paddock when there was still approximately one-third leucaena leaf left overall on the plant and the paddock was then spelled for six to eight weeks. The grass-only cattle only had access to two paddocks each year whereas the cattle on leucaena-grass shifted between six or seven paddocks. From June through to the end of the trial period in both years, the same three leucaena-grass paddocks were used, which were predominantly frost-free. At the beginning of the project there was discussion with the co-operators about the selection of the particular paddocks for this demonstration, however in the end, the project team accepted the decisions made by the co-operator regarding paddock utilisation. This resulted in an elevation difference of approximately 50 m between the most commonly stocked leucaena-grass paddocks and the lower elevated grass-only paddocks.

The feedlot cattle were fed once each day in the morning, with the ration gradually changing as the newly introduced animals went through the pre-feeder, starter and intermediate stages before shifting to the finisher ration for 105 days. The finisher ration had a dry matter content of approximately 76% and consisted of corn, wheat, silage, whole cottonseed, supplement and lime. The grain bin ration was similar, but included hay instead of silage. The oats paddock was prepared similarly in both years, being sprayed for weeds twice (November and December), worked in January, sprayed for weeds and fertilised in February and then planted in March.

3.5 Stocking rate

To calculate the stocking rate for this demonstration, a spreadsheet was constructed to monitor the number of days both trial and non-trial cattle grazed the grass, leucaena-grass and oats trial paddocks during the year. This figure was then multiplied by the number of cattle in each paddock to give total grazing days. Equivalent head per period was generated by dividing the total grazing days by the duration of the trial (364 days in 2011 or 320 days in 2012). A stocking rate of hectares per head (ha/hd) and hectares per adult equivalent (ha/AE) was then calculated by dividing the equivalent head (or AE) per period by the total number of hectares of specific paddocks the cattle accessed.

3.6 Soil sampling

Soil samples to a depth of 10 cm were taken in March 2011 in each trial paddock to determine the levels of the major, secondary and trace elements, acidity, organic matter and salinity. All of these components contribute to the overall health of the soil and influence productivity. During 2012 a management decision meant that a substitute grass-only paddock and leucaena-grass paddocks were used, however these paddocks were not soil sampled due to their proximity and similarity to the original trial paddocks.

3.7 Monitoring pasture and rainfall

Photo-sites were set up in both the grass-only and leucaena-grass paddocks in January 2011 as a point of reference. Photos were taken each time DAF staff visited the property, which equated to more than 20 visits throughout the project. Rainfall records were collected at 'Bannockburn' for the duration of the project and compared against the long-term Dalby mean rainfall.

3.8 Diet quality

Faecal near infrared reflectance spectroscopy (F.NIRS) was used to monitor changes in diet quality under the different finishing systems, in particular crude protein (CP), dry matter digestibility (DMD) and non-grass intake percent. Faecal samples were collected every four to six weeks by DAF staff in 2011 and 2012 from steers grazing leucaena-grass and grass-only, along with the 2011 oats steers. Photos of the faeces, cattle and pastures were also taken each time. An example of a field day slide showing the contrasting photos taken in December 2010 and July 2011, along with a snapshot of the faecal analysis results and cattle performance is given in Appendix 2. Fresh faecal samples were generally found near watering points and two teaspoonsful were collected from approximately ten different dung pats to provide a representative sample. The dung was then oven dried at 60 °C and sent to a Queensland Government laboratory for F.NIRS analysis. During 2011, several dung samples were also tested for phosphorus (Phos) using wet chemistry analysis. This testing was discontinued once it was established that high levels of phosphorus were available to the steers.

3.9 Leucaena bug

Cattle feeding on leucaena need to be drenched with the leucaena rumen fluid inoculum (*Synergistes jonesii* – 'leucaena bug') to prevent mimosine and DHP toxicity, otherwise they can suffer reduced weight gains or even fatality in severe situations.

In the first year of the PDS, 20 non-trial steers, which had been running on leucaena-grass before the start of the trial, were each given 100 ml of the leucaena rumen inoculum *Synergistes jonesii* on 12 November 2010. These 20 steers were grouped with the 69 trial steers until late March 2011. To determine if the steers grazing leucaena-grass were sufficiently protected from DHP toxicity, urine samples were collected and tested at multiple

times. Urine samples were collected from eight steers on 21 January 2011 (week 10 after inoculation), and seven steers on 24 March 2011 (week 18). In the second year, 11 trial steers out of the 75 allocated to the leucaena-grass treatment were inoculated on 22 December 2011, three weeks after being put on leucaena-grass. Urine was collected from three steers on 20 March 2012 (week 13 after inoculation) and six steers on 15 June 2012 (week 25).

To preserve the urine, 9.5 ml urine was added to 0.5 ml concentrated hydrochloric acid in a polypropylene tube, which was then refrigerated. An on-farm test kit modified by Sam Graham and Graham Kerven (The University of Queensland) was used to assess how well the rumen bug was circulating through each leucaena-grass treatment group. The preserved urine was hydrolysed using a water bath and then purified by passing through a 0.45 uM cellulose acetate filter and then a Maxi-Clean 300 mg C^{18} cartridge. One millilitre of the hydrolysed and purified sample was then added to 2 ml of a ferric chloride solution. The tubes were then shaken and any colour change observed after 10 minutes recorded. A yellow or straw colour indicates the leucaena bug is active in the rumen.

3.10 Extension activities and communications

To extend the project findings, three field days were run at 'Bannockburn'. The days were structured so that DAF staff delivered the current project results, guest speakers discussed relevant topics relating to either the project objectives or project findings, interactive paddock sessions were conducted and participants were given ample opportunity to network with each other and presenters. Handouts containing a project summary and key results were distributed and attendees were offered a range of relevant industry publications for further reading. At the conclusion of each field day, participants completed a short, paper-based feedback sheet allowing them to critique each component of the day and offer suggestions for future topics and speakers. Two smaller workshops were also organised, Testing Management Options, which is centred around a spreadsheet-based herd economic modelling tool, as well as a Stocktake Plus app training session to showcase the pasture monitoring decision support tool.

All activities were promoted through the producer group, via email networks, the FutureBeef website, newspapers and flyers at rural agencies. Following activities, especially the final field day, the project team were often approached by several different organisations seeking a story about the demonstration. The Meat & Livestock Australia (MLA) Feedback magazine was used to promote the findings of the project, and staff also spoke about aspects of the project at various conferences and forums throughout the state.

4 Results

4.1 Liveweight gain

The first project objective was to measure steer liveweight gains in the different finishing systems. Over the course of each trial period (364 days in 2011 and 320 days in 2012), steers were weighed six times, with a starting liveweight of approximately 350 kg. There was no significant difference in terms of liveweight gain across breeds in 2011 and vendor in 2012.

4.1.1 Year one (2011)

Average steer liveweights and average daily gains (ADG) for 2011 are shown in Figure 3. The leucaena, oats and feedlot cattle ran as one mob on predominantly frost-free leucaena-grass pastures from November 2010 until June 2011 and were then split into the three

treatment groups. By the end of the first period (June 2011), the steers that were on leucaena-grass pastures were 38 kg per head heavier than the grass-only steers. Once allocated into their treatment groups and assessed at the end of the trial period, feedlot, oats and leucaena steers were 147 kg, 73 kg (lead/best performing steers) and 51 kg respectively heavier than the grass-only steers. The steers grazing on leucaena-grass pastures averaged 256 kg liveweight gain per head over 364 days while the steers grazing grass-only averaged 210 kg. These weight gains equated to an ADG of 0.70 kilograms per head per day (kg/hd/day) for the steers on leucaena-grass and 0.58 kg/hd/day for the grass-only steers. From 12 November 2010 until 21 January 2011, steers on both leucaena-grass and grass-only gained approximately 1 kg/hd/day. Extremely wet conditions in early 2011 and resultant cases of three day sickness are likely to have impacted on weight gains, reducing them to 0.53 kg/hd/day for leucaena-grass and 0.31 kg/hd/day for grass-only. When conditions dried out, high weight gains resumed until winter. During the winter period, the leucaena-grass steers performed just above maintenance whereas those on grass-only lost 0.24 kg/hd/day. However, once spring commenced, these weight gains dramatically increased to close to 1 kg/hd/day. A photo of a leucaena-grass steer in spring is shown in Appendix 3.

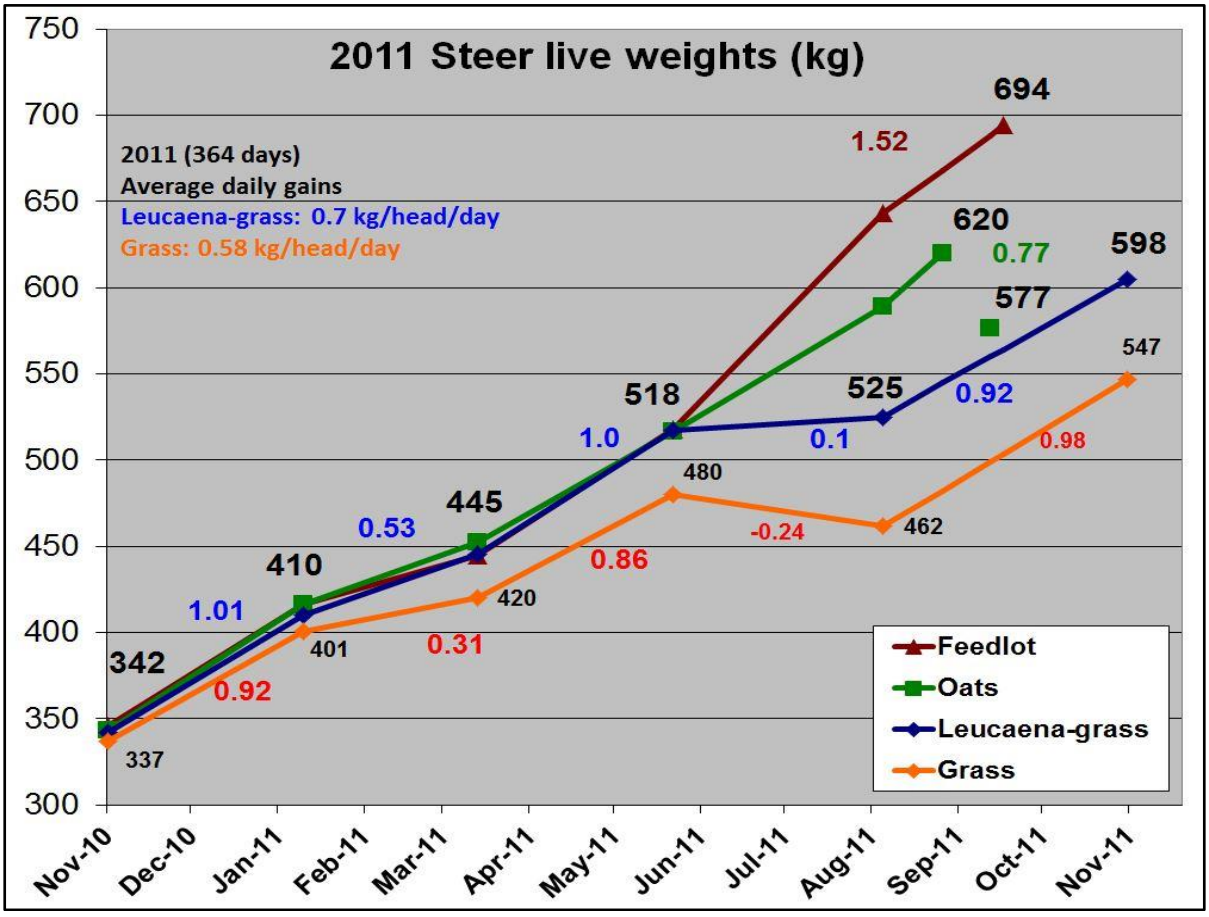


Figure 3: Liveweight and average daily gain (ADG) of steers on grass-only, leucaena-grass, oats and feedlot from November 2010 to November 2011. Numbers in black represent average liveweight (kg) and ADG are expressed in red (grass-only), blue (leucaena-grass), green (oats) and maroon (feedlot).

The ADG of the steers on oats was 0.77 kg/hd/day until 23 September 2011. This value accounts for the 11 lead (best performing) steers slaughtered in early September (620 kg average) and the remaining 12 steers weighed on 23 September (577 kg average), of which nine were slaughtered soon after. The feedlot cattle achieved 1.52 kg/hd/day over a 116 day period.

The box and whisker plots displayed in Figure 4 illustrate the median, the upper and lower quartiles, along with the highest and lowest values in terms of ADG for both the steers on leucaena-grass and grass-only in 2011. The median (line in the centre of the box) for the leucaena-grass steers is clearly higher than the grass-only steers, however, the leucaena-grass steers displayed a much greater variation in ADG, as indicated by the highest and lowest horizontal lines (whiskers). This median difference and greater ADG spread for the leucaena-grass steers also occurred in the second year of the trial (not shown diagrammatically).

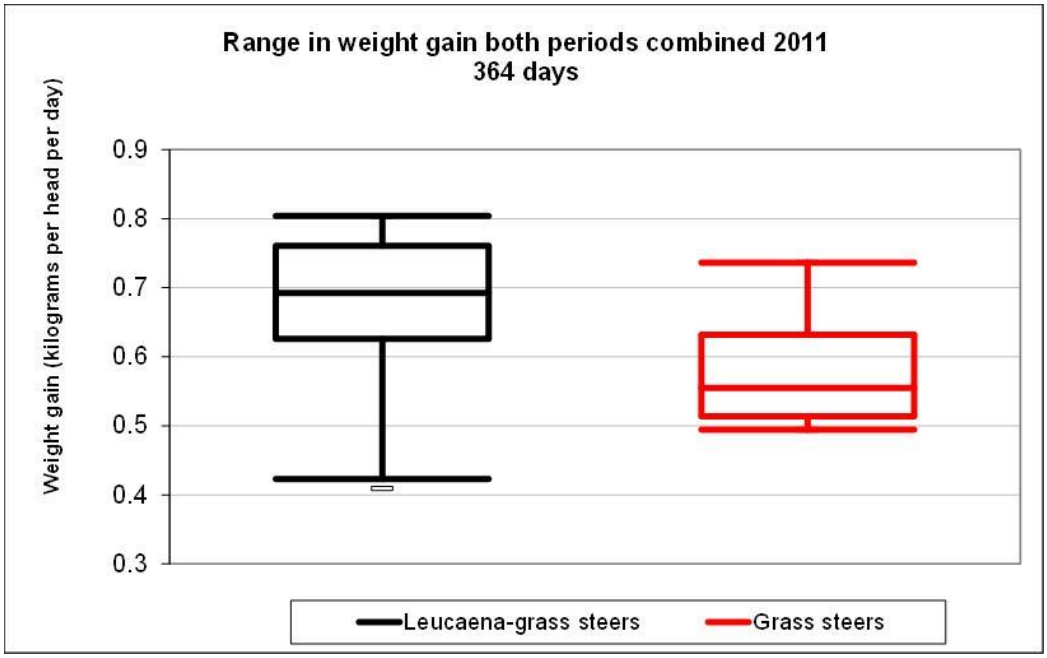


Figure 4: Range in weight gains over both periods during 2011 for the leucaena-grass and grass-only steers with median, upper and lower quartiles displayed.

4.1.2 Year two (2012)

Average steer liveweights and ADG for 2012 are given in Figure 5. The leucaena-grass, oats and feedlot treatment cattle ran as one mob on predominantly frost-free leucaena-grass pastures from December 2011 until June 2012. By the end of the first period, the steers that were on leucaena-grass pastures were only 15 kg per head heavier than the grass-only steers. Once allocated into their treatment groups and the second period finished, the feedlot, oats and leucaena-grass steers were respectively 184 kg, 78 kg and 80 kg heavier than the grass-only. The average liveweight gain over the 320 day period for the steers grazing exclusively on leucaena-grass pastures was 234 kg, giving an ADG of 0.73 kg/hd/day. An example of some of the steers that grazed leucaena-grass pastures for 320 days is shown in Appendix 4. The steers that grazed grass-only gained on average 153 kg of liveweight, giving an ADG of 0.48 kg/hd/day. The total weight gain figures are lower than the previous year, especially the grass-only steers, however this is not surprising given the trial period was 44 days shorter. Unlike in early 2011, the steers from late January to late March performed exceptionally well, with the grass and leucaena-grass steers both achieving 1 kg/hd/day. A photo of some of the steers from the grass-only treatment during this time is shown in Appendix 5. Similar to autumn 2011, the leucaena-grass steers performed slightly better than the grass-only steers. During winter, the leucaena-grass cattle averaged 0.56 kg/hd/day, whereas the grass-only steers lost 0.26 kg/hd/day. The average daily gain of the steers on oats was 0.91 kg/hd/day (80 days), which was slightly better than 2011 and the steers were removed from the oats paddock in one group. The feedlot cattle achieved 1.54 kg/hd/day.

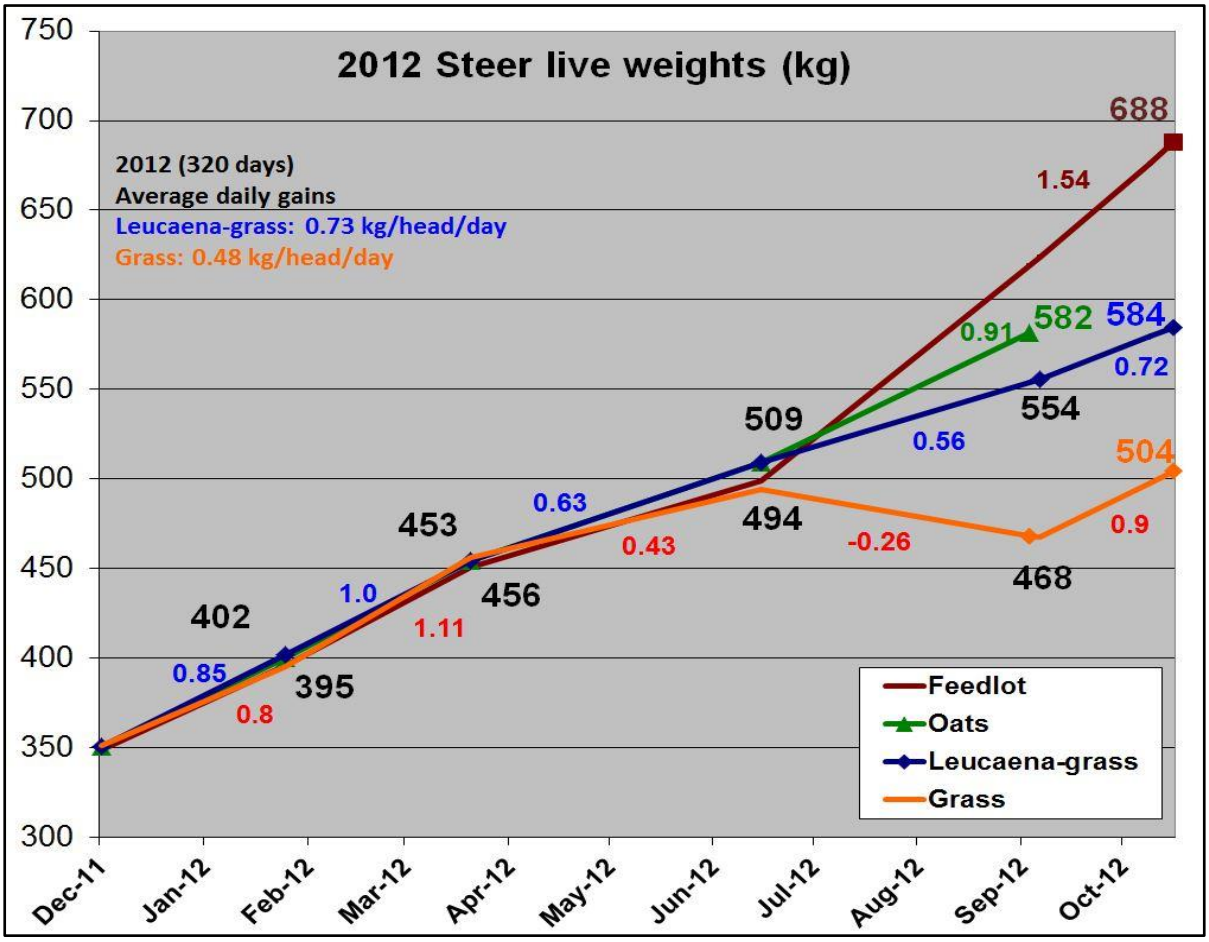


Figure 5: Liveweight and average daily gain (ADG) of steers on grass-only, leucaena-grass, oats and feedlot from December 2011 to October 2012. Numbers in black represent average liveweight (kg) and ADG are expressed in red (grass-only), blue (leucaena-grass), green (oats) and maroon (feedlot).

4.1.3 ADG ranking across periods

Over 2011 and 2012, nine different combinations of feeding regimes (grass-only, leucaena-grass, oats and feedlot ration) and time period (first and second) were assessed (Table 2). These combinations reflect the four main finishing systems evaluated over both years, along with the fifth system of grass-only to feedlot analysed in 2012.

Table 2: Correlation combinations assessed to identify consistent high and low weight gain performers

Combination	2011	2012
Period 1 Grass-only + Period 2 Grass-only	-0.18	-0.13
Period 1 Leucaena-grass + Period 2 Leucaena-grass	0.24	-0.06
Period 1 Leucaena-grass + Period 2 Oats	-0.11	0.19
Period 1 Leucaena-grass + Period 2 Feedlot	-0.07	0.62
Period 1 Grass-only + Period 2 Feedlot		-0.71

In summary, seven of the nine combinations assessed produced a poor correlation. The 0.62 figure generated by the steers that grazed leucaena-grass for six months and then entered the feedlot in 2012, was considered an outlier. Also in 2012, the steers that grazed grass-only for six months and then entered the feedlot produced –0.71, suggesting that compensatory gain had occurred.

4.2 Production figures

Table 3 shows paddock sizes, stocking rates and liveweight performance for the four different feeding regimes: grass-only, leucaena-grass, oats and feedlot. Across the two trial years the stocking rates were similar, though slightly lower in 2012. Stocking rates were broadly determined by the project team at the commencement of the trial, although the property manager ultimately controlled the rate in order to optimise both cattle and pasture performance. All trial paddocks had the pasture and soil condition assessed at the start and end of the project, with the result being 'good' land condition across all paddocks.

In both years, steers grazing leucaena-grass year-round produced more than double the kilograms of liveweight per hectare compared to those on grass. This result was considered by many producers to be a key finding of the PDS.

Table 3: Production figures for the four feeding regimes (grass, leucaena-grass, oats and feedlot) in 2011 and 2012. *NB: Other cattle grazed these paddocks and were accounted for in the stocking rate calculations.*

2011 (364 days)	ha	Equiv hd / period	ha/AE	ha/hd	ac/hd	Wt in	Wt out	kg/hd	kg/ha	Days	ADG
Grass	32	19.1*	1.68	1.68	4.1	337	547	210	125	364	0.58
Leucaena-grass	134	131.7*	1.05	1.02	2.5	342	598	256	252	364	0.70
Oats (105 days)	13.5	31.6*	0.37	0.43	1.1	518	599	81	190	105	0.77
Feedlot (no HGP)						518	694	176		116	1.52

2012 (320 days)	ha	Equiv hd / period	ha/AE	ha/hd	ac/hd	Wt in	Wt out	kg/hd	kg/ha	Days	ADG
Grass	42.7	21.2*	2.03	2.01	5.0	351	504	153	76	320	0.48
Leucaena-grass	157	120*	1.36	1.31	3.2	350	584	234	179	320	0.73
Oats (80 days)	13.5	25	0.47	0.54	1.3	509	582	73	134	80	0.91
Feedlot (no HGP)						499	688	189		123	1.54

* This is a cumulative total allowing for rotations and additional non-trial cattle which grazed the trial paddocks for a period of time during the demonstration.

4.3 Economic performance

4.3.1 Finishing system averages

The economic performance of the finishing systems was determined by calculating the partial return on the livestock capital invested for each system. A return was generated for the first period before the 'split up' in June; for the second period after June; annually, and after the second period when the steers were finished on grain bins. Table 4 provides an overview of the economic results.

Table 4: Partial return on livestock capital invested in the finishing systems, 2011–2012

	First period return (summer/autumn)			Second period return (winter/spring)		Annual Return (AR)		Post second period return (grain bin finished)	
	2011	2012		2011	2012	2011	2012	2011	2012
Leucaena - grass	19%	9%	Leucaena - grass	6%	6%	26%	18%		5% (Bin) 35% (AR)
			Oats	3%	2%	22%	10%	1% (Bin) 24% (AR)	2% (Bin) 13% (AR)
			Feedlot	10%	13%	31%	23%		
Grass-only	7%	7%	Grass-only	6%	-5%	14%	-1%		14% (Feedlot with HGP) 17% (AR)
			Feedlot		15%		28%		

The high input finishing systems i.e. those encompassing leucaena-grass, oats or the feedlot, produced significantly higher annual returns than the grass-only system in both years. The highest annual returns were achieved when steers grazed leucaena-grass for six months and were finished in the on-farm feedlot. This was followed by steers that grazed leucaena-grass year-round, then steers that grazed leucaena-grass for six months and finished on oats. The steers that grazed grass-only for the entire trial period recorded the lowest return in subsequent years. In 2012, the steers that grazed grass-only for six months and then finished in the on-farm feedlot produced a favourable return; however this result was based on a small number of steers.

The spreadsheet containing a comprehensive breakdown of the input values used to generate the returns in Table 4 is extensive and difficult to display in a report. Consequently, a copy of only one period for each of the different feeding regimes: grass-only, leucaena-grass, oats and feedlot is provided. These four breakdowns, with an additional worksheet for the feedlot costings, can be found in Appendices 6-10. A more succinct version of the inputs used to generate the first period partial return, or percent net value added, for the 2011 leucaena-grass and grass-only steers is shown in Table 5.

Table 5: Comparison of the economic performance of steers on grass-only versus leucaena-grass during the first period (November 2010 until June 2011)

	18 steers on grass-only (per head)	69 steers on leucaena-grass (per head)
Value in paddock at end	$888 (480 kg)	$957 (517 kg)
Value in paddock at start	$742 (337 kg)	$738 (343 kg)
Gross value added	$164 (143 kg)	$218 (174 kg)
Opportunity cost of steer capital	$20	$20
Opportunity cost of pasture development and land capital	$80*	$56
Other costs	$17*	$4
Net value added (per head)	$48	$137
% net value added over period	6.65%	18.58%

**In this example, the costs per head are significantly higher for the grass-only steers due to the costs attributed to the grass system being spread over fewer cattle (18) compared to the leucaena-grass system (69). These differences are not as large in the other three periods analysed. The absolute*

cost of labour is the same in each case as the assumption was made by the manager that the time taken to handle the livestock was very similar even though the mob sizes were different. This assumption is likely to hold where paddocks are of a similar size but have quite different stocking rates – similar to the differences shown for the grass and leucaena based treatments in this demonstration. Calculating the costs per head based on relative stocking rates may have reduced the relative differences but would have no real impact on the absolute economic performance or the ranking of the treatments.

4.3.2 Individual returns and rankings

In the latter stages of the project, to assess the spread in economic performance, the partial returns produced by individual trial steers were investigated. A table displaying the range in individual returns is given in Appendix 11. An example of the range in returns in individual returns is –2.5% to 52% for the steers which grazed leucaena-grass for six months and then entered the feedlot in 2011.

Ranking the steers on an individual return basis allowed for an assessment of how well they performed within their treatment group in the first period and from an annual return perspective. This was done to determine if decisions could be made in June whether to retain or sell an animal based on their profitability. Only the steers in the leucaena-grass or grass-only treatments for 12 months were investigated. Due to the number of steers in these treatment groups in both years, the leucaena-grass treatment was evaluated based on five increments of 20%, whereas the grass-only treatment group was divided into three increments of 33%. For the individual returns in 2011, four out of five leucaena-grass steers in the bottom 20% for period one, remained in the bottom 20% based on annual return. In other words, 80% of the bottom performers during period one remained bottom performers when evaluated on an annual return basis, hence an opportunity existed to remove these less profitable animals from the system in June, rather than carrying them through to the end of the year. The percentage of grass-only and leucaena-grass steers that continued to be high or low economic performers from a first period and annual perspective can be seen in Table 6.

Table 6: Proportions of stock continuing to be high or low economic performers

Year	No. of Hd	Treatment	Comment (first period and annually)
2011	18	Grass-only	66% remained top 33% 66% remained bottom 33%
2011	25	Leucaena-grass	60% remained top 20% 80% remained bottom 20%
2012	15	Grass-only	60% remained top 33% 60% remained bottom 33%
2012	25	Leucaena-grass	100% remained top 20% 80% remained bottom 20%

By using RFID numbers and records, it could be determined whether or not high content Charolais/Angus/Shorthorn steers and/or particular vendors' steers were ending up in the bottom or top 20–33% on the various feeding regimes based on individual returns. It was

found that in 2011, the Charolais, Angus and Shorthorn steers from the one vendor evenly ranked in the top and bottom 20–33%, as was the case for the two vendors' steers in 2012, hence no bias transpired.

4.4 Factors influencing the pasture

4.4.1 Rainfall

The rainfall at 'Bannockburn' during the PDS was highly variable, as shown in Figure 6. The property received well-above average rainfall at the start of the project in December, January and March and during the spring, however winter rainfall was below average. In 2012, the property received 360 mm less than the previous year total; with summer being just above average and the remainder of the year dipping and falling below the Dalby long-term mean.

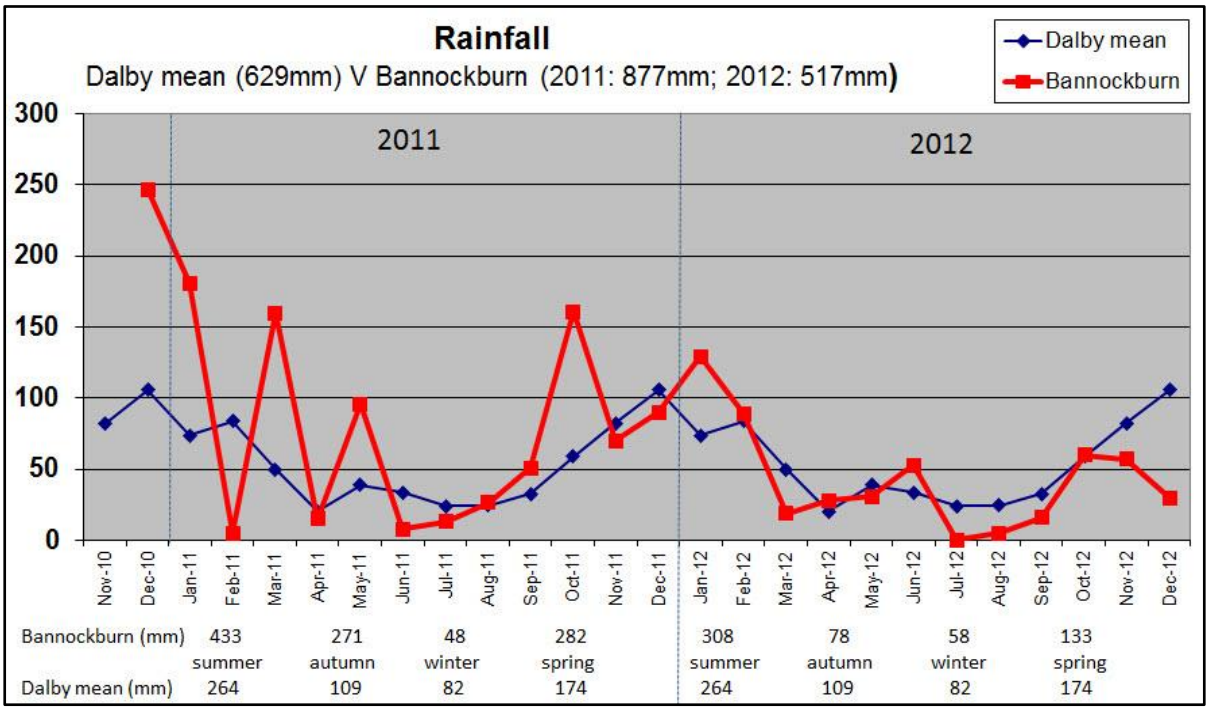


Figure 6: Monthly rainfall for Bannockburn during 2011 and 2012, compared to Dalby mean monthly rainfall.

4.4.2 Soil health

Seven paddocks used in the trial had soil tested to a depth of 10 cm in March 2011, with all sample results showing there were adequate nutrient levels for desired production. Appendix 12 provides soil test results from one of the grass-only and leucaena-grass paddocks, and the oats paddock.

4.4.3 Temperature

Temperature was not recorded at 'Bannockburn', so the figures presented in this report are from the Bureau of Meteorology weather station located at Dalby, approximately 40 km south of 'Bannockburn'. The highest temperature recorded during the trial was 32.4°C in February 2011, with the second highest (31.5°C) observed in November 2011. During the winter of 2011, a minimum temperature of 1.4°C was recorded in July, whereas in August 2012, 2.7° C was recorded. These minimum temperatures resulted in parts of 'Bannockburn' receiving frosts, although not as severe as previous years.

4.5 Diet quality

Faecal samples were collected regularly throughout the project, with CP, DMD and non-grass intake percent being the three main components of the F.NIRS investigated. Phosphorus (P) analysis on faecal samples were done using wet chemistry procedures early in the project, but discontinued once it was established that P levels were adequate in the pasture.

4.5.1 Crude protein

Figure 7 shows the crude protein levels in the diet of steers grazing leucaena-grass or grass-only pastures. As expected, percent CP was higher in the leucaena-grass paddocks than in the grass-only paddocks for both years, with the exception of one sample in July 2011. The grass-only percent CP was approximately 6% on four occasions but reached almost 13% in spring 2011. Whereas the lowest leucaena-grass level was 7%, while approximately 15% was attained on three collections.

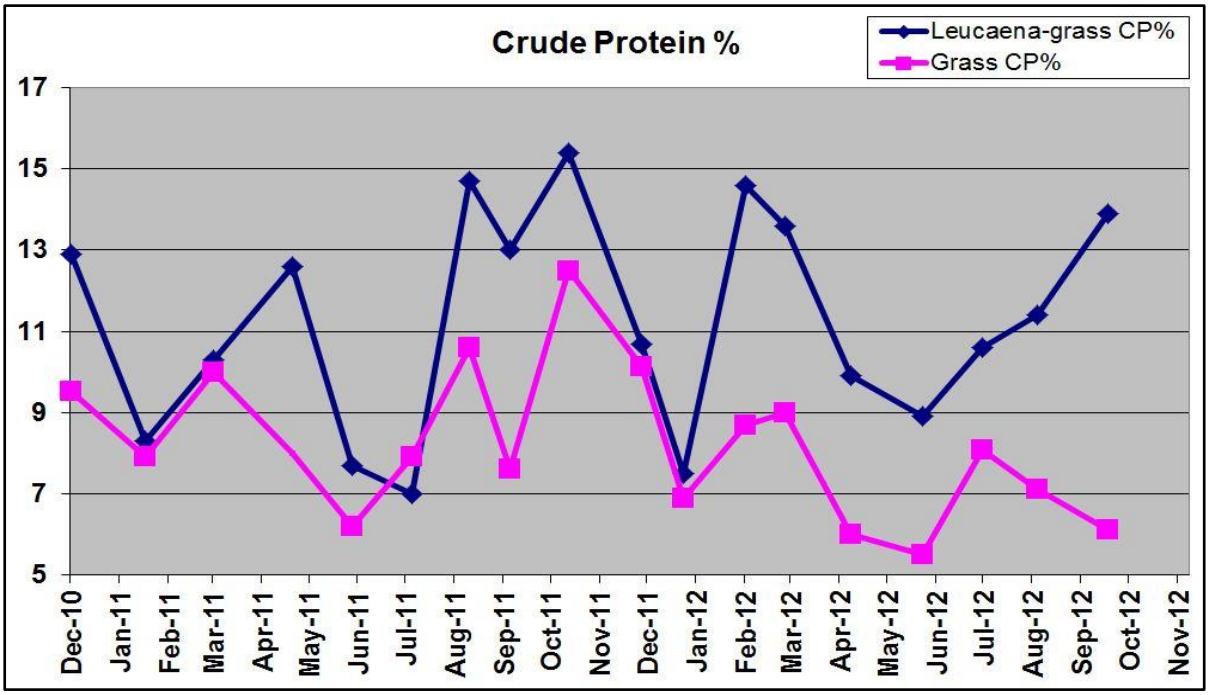


Figure 7: Faecal NIRS crude protein percentages for steers on grass-only and leucaena-grass in 2011 and 2012.

4.5.2 Dry matter digestibility

Figure 8 shows that the percent DMD of the feed was generally higher for the leucaena-grass paddocks than the grass-only paddocks. The leucaena-grass had 'high' levels (>60%) from August 2011 through to October 2012. Only 'fair' levels of DMD were attained in the grass-only paddocks over each winter.

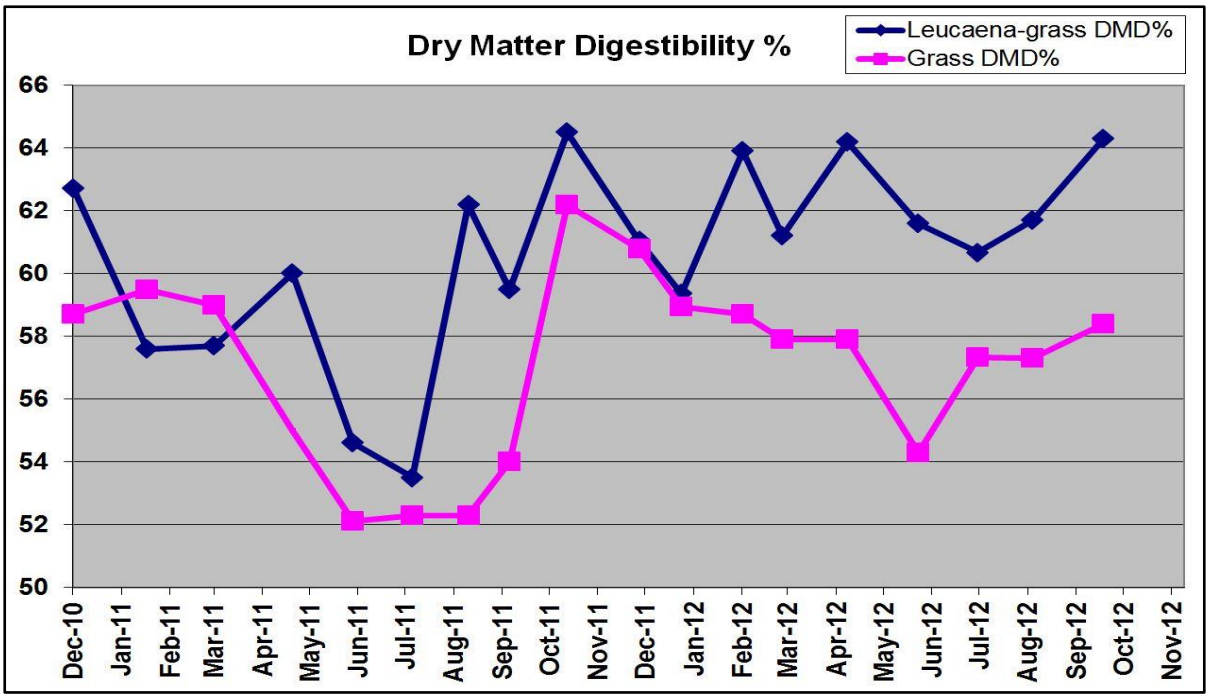


Figure 8: Faecal NIRS dry matter digestibility percentage for grass-only and leucaena-grass paddocks in 2011 and 2012.

4.5.3 Non-grass intake

The non-grass intake percentage represents the portion of the diet that is not grass in a botanical sense. As expected, the non-grass component of the diet for cattle on leucaena-grass was generally higher than that for cattle in grass-only paddocks (Figure 9). Over winter in both years, the non-grass intake levels increased noticeably for the grass-only treatment.

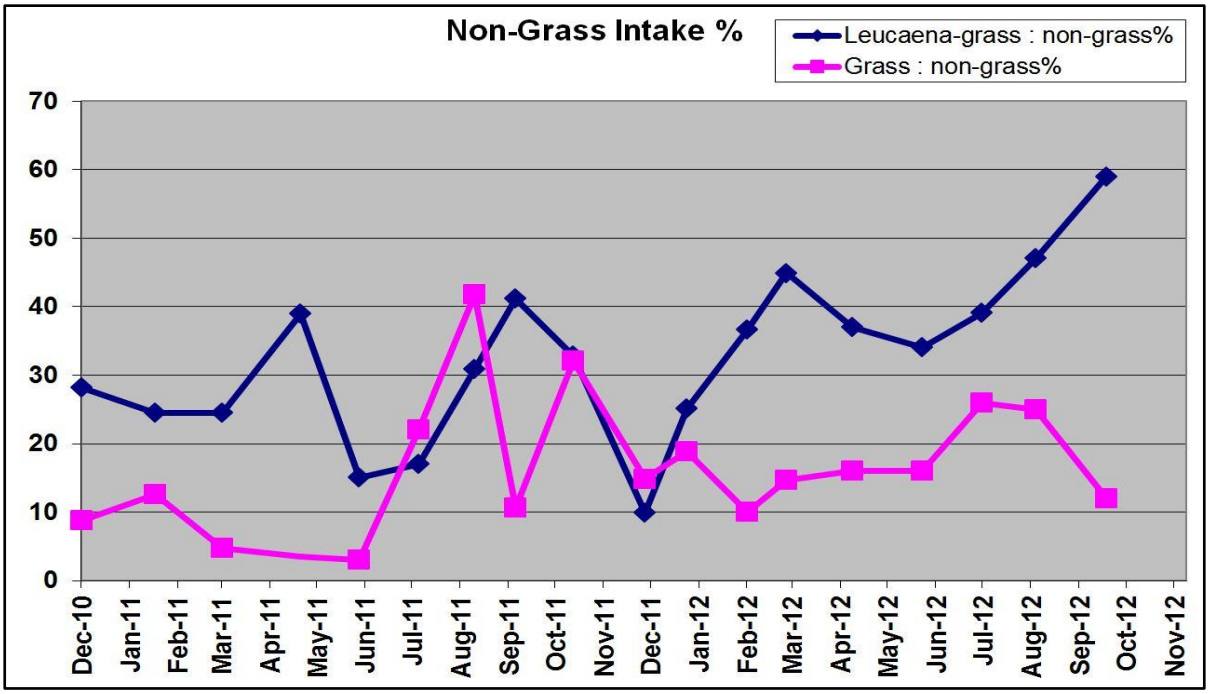


Figure 9: Faecal NIRS non-grass intake percentage for grass-only and leucaena-grass paddocks in 2011 and 2012.

4.5.4 Phosphorus

Faecal phosphorus samples from the leucaena-grass and grass-only paddocks were assessed in 2011. All samples showed very high levels ranging from a high of 0.78% in December 2010, to a low of 0.37% in June 2011 (Figure 10). Levels below 0.2% are considered low.

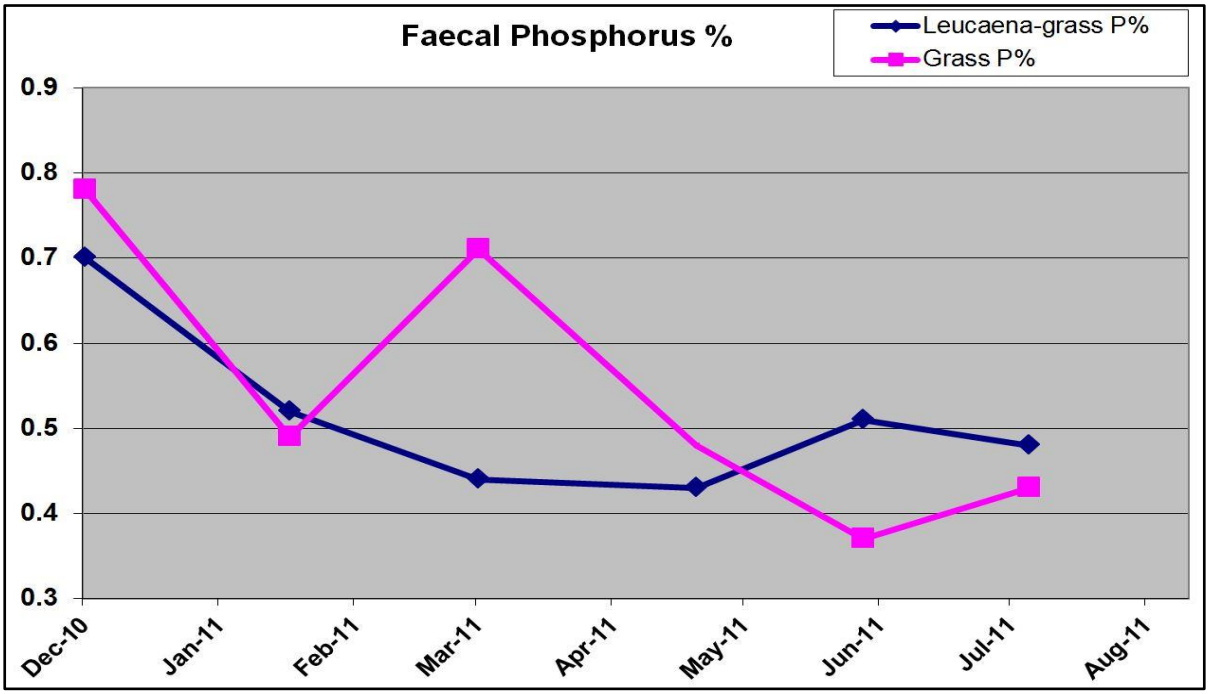


Figure 10: Faecal NIRS phosphorus levels for the grass-only and leucaena-grass paddocks in 2011.

4.5.5 Oats

Faecal samples were collected from the oats steers in 2011. Analysis showed 71% DMD and 27% CP at the start of grazing. Levels declined before stabilising to approximately 64% DMD and 12% CP for the remainder of the grazing period (Figure 11).

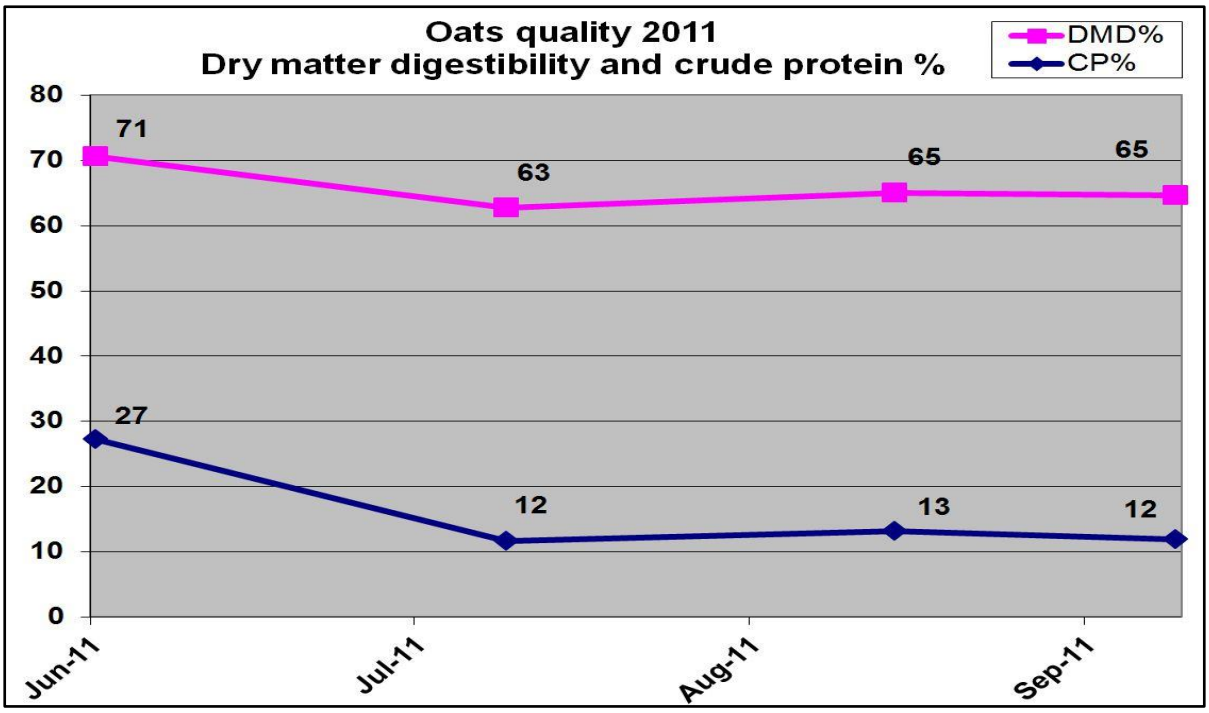


Figure 11: Faecal NIRS CP and DMD in 2011 for the oats treatment paddock.

4.6 Leucaena bug

To determine if the rumen bacterium, *Synergistes jonesii*, was circulating through the steers grazing leucaena-grass, urine samples were collected at weeks 10 and 18 post inoculation in 2011 and weeks 13 and 25 in 2012. All eight samples obtained at week 10 remained yellow/straw coloured after having been hydrolysed, purified and added to ferric chloride solution (see Appendix 13). Of the seven samples from week 18, one remained yellow whereas the remainder changed to a slightly orange colour (see Appendix 14). Of the three samples collected at week 13 in 2012, two went slightly orange and one stayed yellow. The six samples collected at week 25 produced a 50/50 split result of yellow and slightly orange.

4.7 Additional data collection

4.7.1 ADG data with a HGP

In the third year of the PDS, 2013, the Ferriers made a business decision to commence implanting all steers on their grazing country with an HGP. They monitored 122 HGP crossbred steers on leucaena-grass pastures from 7 February to 19 April. The steers had an approximate starting liveweight of 370 kg and achieved 1.02 kg/hd/day. Faecal samples were collected over the 71 day period to determine diet quality and allow comparison of the CP%, DMD% and non-grass intake% over a similar time period in 2012. However, due to a freezer malfunction, the samples were accidentally discarded. Despite this, the weight gain figures can be added to the Ferrier's pool of data for steer performance on leucaena-grass over summer and early autumn at 'Bannockburn'.

4.7.2 Cost of gain

Given that producers often discuss cost of gain (COG) when comparing different finishing systems, these calculations were generated out of interest in 2011.

The COG results were:

Grass-only	$0.68/kg
Leucaena-grass	$0.61/kg
Oats	$1.75/kg
Feedlot	$2.04/kg (feed only; feed conversion is 8.5 kg as fed basis)

4.7.3 Meat Standards Australia (MSA)

In 2012, 35 steers that had access to either leucaena-grass or grass-only for six months were placed in the feedlot in June. At slaughter at an MSA licensed abattoir on 18 October 2012, 97% of the steers graded MSA, with an average boning group of 6.8. All steers were milk and two teeth with an average fat depth of 19 mm and average carcase weight of 370 kg.

4.8 Extension activities and communications

The final objective of this PDS was to communicate the results and learnings of the demonstration to a broad range of stakeholders in the region through field days and media releases. Table 7 provides an overview of the planning meeting and field days run as part of the PDS. It captures the number of attendees, the guest speakers and their topics and the overall feedback rating given regarding the value of the event to the producer's business. To assist local beef producers in gaining a better understanding of whole farm economics, a one day Testing Management Options workshop was also conducted in Bell on 9 September 2011, with 10 producers (seven businesses) attending. Additionally, a Stocktake Plus app training session was held in Bell on 9 October 2013, with six producers (four businesses) attending.

Table 7: Planning meeting and field days conducted during the project

Event / date	Attendees	Speakers and topics	Feedback (Value to the business)
Planning meeting 20 December 2010	13 (8 businesses)	DAF project staff Background to the PDS, objectives, Method, sequence of activities	6.25/7
Field day 3 June 2011	46 (31 businesses)	DAF project staff Cattle performance to date, faecal NIRS, soil test results, urine collection findings Rob Lawrence (IAP) Feedlot nutrition Dave Lawrence (DAF) Soil health & soil testing Glen Whitton (Riverina) Supplementation	5.95/7
Field day 2 December 2011	50	DAF project staff Year 1 performance data, faecal NIRS Fred Chudleigh (DAF) Economics of the finishing systems Dave McRae (QCCCE) Historical climate data & seasonal outlook Stewart Taylor (NAPCO) Incorporating forages into a backgrounding operation and trial work	5.73/7
Field day 26 April 2013	100	DAF project staff Overall project findings Professor Roger Stone (USQ) What to look for in the upcoming season Courtney Ramsey (Bell Vet Services) Three Day Sickness Jonathan Schmidt (Burenda Angus) Burenda Angus and its forage options Peter Ramsey (Elanco) Understanding HGPs and rumen modifiers Col Paton (EcoRich Grazing) Forage budgeting	5.95/7

Table 8 provides some of the positive comments given on feedback sheets at the various field days. The feedback questions centred on the value of the day to the producer's business, the most interesting information learnt and conclusions drawn from what people

Table 8: Field day participants' feedback

Producer	Comments
1	I plan on improving my record keeping and implementing fodder budgeting
2	Sell saleable cattle so I don't run out of grass even though I may not get top dollar for them
3	F.NIRS is something I had never considered before but will now; there's lot of different variables involved in doing cost benefit analysis; stimulated thinking and conversation
4	Thank you for the range of topics on the day (NAPCO and climate)
5	There's a need to analyse data especially if you are working on a large scale as the right decision can make a huge impact; I wish I could have attended the other workshops
6	I need to better monitor to aid decision making; excellent information sharing from the co-operators
7	Always valuable to hear other people's results, stories and methods
8	Field days such as this challenge you and make you further question your business; cost of production is king
9	It was alarming to see such a weight loss on grass in winter
10	Definitely has me thinking more about what we are doing
11	Great insight into how more 'advanced' operations run their cattle and manage their country

After each field day, in particular the final field day held in April 2013, the project team were approached by media personnel from various organisations for a story regarding the PDS. Table 9 lists the media articles generated from this PDS.

Table 9: Media articles generated from the PDS

The Leucaena Network News Cattle Finishing Producer Demonstration Site (PDS)	August 2011
Rural Weekly Field day beefs up knowledge	9 December 2011
Queensland Country Life Knowledge beefed up at Bell field day	29 December 2011
The Leucaena Network News Bonnie Doon PDS trial results	February 2012
Beef Central Finishing systems put to economic test	2 February 2012
Australian Farm Journal Cattle finishing comparison shows value of leucaena-pasture combination	May 2012
Queensland Country Life Bell rings leucaena promise	2 May 2013
Beef Central (2 parts) Crunching the numbers on finishing systems; Producer outlines practical lessons on leucaena management	2 May 2013
MLA Feedback Field day a front-runner	July 2013
MLA Feedback First across the finish line; Growing the knowledge base	September 2013
FutureBeef eBulletin Which finishing systems stack up?	11 September 2013
The Leucaena Network News Which beef cattle finishing systems stack up?	February 2014
Farming Ahead Beef cattle finishing systems put to the test	May 2014
CQ Beef issue 21 Which beef cattle finishing systems stack up?	Winter 2014

As the project gained increased interest from industry, the project leader, Tim Emery, discussed the project findings at numerous forums across the state (see Appendix 15). At two forums, Ranald Ferrier (property owner) and Steve Munge (property manager) also co-presented to provide a producer perspective into the 'Bannockburn' operation. Table 10 lists forum locations and attendee numbers.

Table 10: Forums where PDS results were presented

Date	Event	Attendees	Presenter
31 May 2012	MLA BeefUp Forum - Durong	128	Tim Emery
1 June 2012	MLA BeefUp Forum - Biggenden		
22 June 2012	'Beef at Injune'	60	Tim Emery
21 March 2013	Leucaena Network Annual Conference - Redlands	35	Tim Emery and Ranald Ferrier
12–15 August 2013	Northern Beef Research Update Conference (NBRUC) - Cairns	25 (viewed presentation)	Tim Emery and Roger Sneath constructed a poster and Tim gave a short presentation
14 November 2013	Young Beef Producers' Forum - Roma	160	Tim Emery and Steve Munge
28 March 2014	Leucaena Network Annual Conference - Emerald	47	Tim Emery
25 July 2014	Gympie Carcase Classic	50 (viewed presentation)	Tim Emery

4.9 Practice Change

To gauge the number of producers with the intent to change as a result of attending a particular field day, each field day feedback sheet contained the question 'Has the day influenced your decision to change aspects of your business?' At the 3 June 2011 field day, five participants said yes and/or provided what aspects will be changed. The 2 December 2011 field day resulted in 12 positive responses and the final field day held on 26 April 2013 inspired 29 participants to have intent to change.

To assess the overall impact of the project and associated activities on the Ferriers, Steve Munge, the producer group, other project participants and their respective businesses, 13 face to face conversations and phone call interviews were undertaken by the project leader 6–12 months after the final activity.

Table 11 lists comments from three producers who were interviewed and had attended the final field day and indicated on their feedback sheet that the event had influenced their decision to change a particular aspect of their business.

Table 11: Final field day participants' feedback in relation to practice change

Producer	Comments
1	I found the final field day to be one of the best days I've attended. The amount of detail provided, especially in the take home booklet, was wonderful and I was able to share this information with my brother. I've since kept a better eye on the costs of my operation, in particular for my oats crops, and I've gone back to weighing cattle on and off the crop, along with valuing the animals as they enter the crop. I'm set on planting leucaena when the seasonal conditionals are favourable to do so.
2	I have elevated country similar to that at Bannockburn and after seeing the PDS results, I tried establishing leucaena in late 2012 and 2013 however it failed to establish due to unfavourable conditions. I am adamant however to get it established and believe it will significantly increase production by being a substitute for summer forage crops and reduce the need for purchasing a dry season supplement.
3	After hearing the presentation about the benefits of using HGPs at the final field day, I decided to implant my next lot of purchased cattle with the aim of improving weight gains and returns.

The Stocktake Plus app workshop also resulted in practice change, with one participant setting up monitoring sites across their property, taking photos and explaining to their partner the functionalities of the app.

Table 12 summarises practice change discussions held with original producer group members and some producers who were regular field day attendees.

Table 12: Feedback from the PDS producer group and regular attendees at PDS activities

Producer	Comments
1	• I see the benefit of weighing cattle and thus realise the necessity to get some scales • I'm currently getting my records in better order • We were surprised with the weight gain on oats – thought it was a bit low • I'm sold on leucaena for its feed value – I've seen it perform over the fence and I'm on similar suitable country • I've established great networks through the project and have recently contacted some people from the group to further discuss their trials and tribulations with leucaena • Recently planted 30 acres of leucaena after acquiring the necessary rain
2	• Definitely made me think • I'm looking to buy scales • Keen to plant leucaena after seeing it perform • Keen on the idea of having a grain feeder in the paddock to keep cattle going forward
3	• I enjoyed the field days immensely – it's great for people to come together to share ideas
4	• Definitely a lot keener on leucaena – impressed by the weight gain and kg/ha • Recently planted ~70 acres of leucaena after receiving adequate rain
5	• Good food for thought • Thinking more about planting leucaena • Provided another perspective on crunching the numbers • Allowed me to see if my steer weight gains are on the right track • I used the economic spreadsheet tool and discovered that my home -made spreadsheets provided a similar result which was pleasing
6	• Got me thinking • TMO highlighted there's an opportunity to get more viable if I get bigger • Reinforced that leucaena is a good option • Learnt something at every event I attended
7	• The trial simply confirmed what we're doing is right, that is using leucaena in our business • The performance attained by the steers was about what I thought they'd achieve

As the PDS was conducted at 'Bannockburn', the data collected and results generated were of most relevance to the Ferriers and Steve Munge. Since discovering that grass-only steers lost an average of 0.25 kg/hd/day during the winter of 2011 and 2012, the Ferriers have decided that in future winters, all cattle not grazing oats or in the feedlot, will have access to either leucaena-grass or a grain based ration in bins in order to keep them gaining weight.

They have also decided to implant steers running on grazing country with a HGP with the aim of maximising weight gain and increasing throughput in their operation. The feedlot ration has also been fine-tuned over time, resulting in weight gains increasing by 15-20% on the EU cattle.

Oats is no longer used in the operation for finishing cattle, but instead for simply getting steers up to feedlot weight and thus a higher stocking rate than that applied in the trial can be implemented. All cattle leaving Bannockburn are now feedlot finished, both from non-EU and EU pens (cattle generally supplied from the Ferrier's Roma property), with the average carcase weight of steers turned off being 345 kg with 15 mm of fat. This average carcase weight and fat depth has increased since the PDS.

The following dot points are comments made by the Ferriers and Steve Munge about what they have learnt from the PDS:

- Laid bare the extent to which weight gains go backwards in winter on grass-only and the importance of filling the feed gap and having value adding options to keep weight gain improving during the colder months
- Exceptionally happy with the performance of the leucaena-grass (weight gains, achievable stocking rates and kg/ha)
- More independent and rigorous research data than ever expected or dreamt of – gives us a pool of data we can draw upon to aid management decisions
- It's important to carefully consider where leucaena-grass is grown – a frost free location definitely provides greater production potential
- Would likely plant more leucaena-grass if had suitable country

5 Discussion and conclusions

This PDS has provided valuable insight into the economic performance of the different finishing systems used on the North-Eastern Downs. It has provided producers with data and tools to use for decision-making in their own businesses. New knowledge gained through field day presentations and networking has established a platform for increasing on-farm practice change.

The key findings specific to this PDS at Bannockburn during 2011 and 2012 are:

- Steers grazing predominantly frost-free leucaena-grass pastures year-round produced more than double the kilograms of liveweight per hectare (kg/ha) when compared to those on grass-only, due to the combined effect of higher average daily gains and a higher stocking rate.

- The high input finishing systems i.e. those encompassing leucaena-grass, oats or the feedlot, produced significantly higher annual returns than the grass-only system in 2011 and 2012.

- The highest annual returns were achieved when steers grazed leucaena-grass pastures for six months and were finished in the on-farm feedlot.

- Steers grazing grass-only lost, on average, 0.25 kg/hd/day during winter in both years, whereas the leucaena-grass steers gained weight (0.1 kg/hd/day in 2011 and 0.56 kg/hd/day in 2012).

- Over the summer, steer weight gains were similar on leucaena-grass and grass-only.

- Steers grazing leucaena-grass pastures displayed a much greater range in ADG than those steers on grass-only.

- An opportunity exists to identify steers with low individual returns after summer/autumn and sell them, as they are likely to produce a low annual return.

5.1 Liveweight gain

In 2011, roughly equal numbers of high content Charolais, Angus and Shorthorn steers from a single vendor were allocated to the four treatment groups. In the following year, each treatment group consisted of similar cattle numbers from two different vendors. In both years cattle were spread across the treatments based on liveweight, resulting in there only being a 10 kg difference in the average starting liveweight of each treatment group. Early in the project it was demonstrated that there was no significant difference in weight gains between the Charolais, Angus and Shorthorn steers. Later in the project, further analysis showed that all three breed compositions featured in the top and bottom 20–33% for individual partial returns on each of the feeding regimes. This validates that comparisons can be made across treatments. The economic performance of the 2012 trial steers followed a similar pattern to the 2011 steers, with both vendors' cattle performing both strongly and poorly under the various finishing systems.

Over both years of the trial, the steers on leucaena-grass pastures produced higher individual weight gains than those grazing grass-only. This was not surprising given that the leucaena was predominantly frost-free and maintained green leaf year round, hence providing a higher quality diet. The F.NIRS results showing mostly higher crude protein and DMD levels for steers on leucaena-grass pastures supports this finding. Over summer, the ADG was similar on either grass-only or leucaena-grass pastures. Consequently, the property manager at 'Bannockburn' is now comfortable in using grass-only paddocks over summer if required, as part of a rotation to rest the leucaena-grass, without sacrificing weight gain.

Several producers expected the average performance on oats to be higher than that measured (0.77 kg/hd/day in 2011 and 0.91 kg/hd/day in 2012). A general perception across industry is that cattle on oats will consistently achieve 1 kg/hd/day. There were animals that reached this level in this PDS, yet when averaged across the mob, the ADG was lower.

Similarly, the feedlot average daily gain of just over 1.5 kg/hd/day was considered by some to be lower than expected. It is important to note that these steers did not have an HGP and that this was one of the first times that EU cattle were fed in the 'Bannockburn' feedlot. The feedlot ration has since been fine-tuned to increase average daily gains by 15-20%.

By monitoring ADG every two months, the impact of specific events such as the extremely wet conditions in early 2011 and compensatory gain of the grass-only cattle in spring were highlighted.

5.1.1 Weight gain rankings

Individual cattle showed mostly poor correlations with consistently high or low performance in terms of ADG across different feeds and time periods. The strongest correlation, yet inverted, was –0.71 for 10 steers that grazed grass-only for six months and then entered the feedlot in 2012. This suggests that the steers which performed poorly on grass in the first period then experienced compensatory gain and achieved some of the highest weight gains in their group in the feedlot.

Similarly, an additional approach of ranking steers on weight gain to see if they remained in the top or bottom group (five or six head) within their treatment across time periods also gave inconsistent results. Only one in five or less of the steers that were either high or low in the first period maintained their status in the second period.

This supports the poor weight gain correlation findings in Table 2 and highlights that weight gain rankings from the first half of the year is a poor predictor of ranking outcomes within a cohort in the second half of the year. It would be desirable to investigate this further using a larger data set.

5.2 Production figures

The production figures for the two trial periods were summarised in Table 3. Stocking rates were similar for the two years, albeit slightly lower in 2012. Suitable stocking rates were discussed early in the project, but ultimately the property manager determined the rates as the trial progressed. Photo-sites showed that the stocking rates determined by the property manager were suitable and that liveweight gain could be maximised whilst maintaining a healthy, productive grazing resource.

The kilograms of liveweight produced per hectare (kg/ha) by steers grazing leucaena-grass pastures was double that of the steers on grass-only. This result has heavily influenced the decision of some local producers to plant leucaena on their own property.

Production figures in this PDS reflect the findings of the High-Output Forages Project conducted by Bowen et al. (2015), in the Fitzroy River catchment of Queensland from 2011-2014. They found that leucaena-grass pastures produced on average, across all sites and years,198 kg/ha/annum,whereas the perennial grass pastures averaged 76 kg/ha/annum. Furthermore, with leucaena-grass pastures there was less variability between sites and years in total beef production compared to perennial grass-only pastures.

5.3 Economic performance

The second objective of this PDS was to ‘determine the relative economic performance of the different production systems’. The key economic message from the PDS was that the high input finishing systems i.e. leucaena-grass, oats or the feedlot, produced significantly higher annual returns than the grass-only system in 2011 and 2012 at ‘Bannockburn’.

The grass-only system did not perform as well due to a combination of the weight loss during winter and the resultant lower annual ADG, lighter stocking rate and longer period required to meet target weights. The -5% return for the grass steers in the second period of 2012 may be attributed to the average steer liveweight being very similar at the June and October weighings and the steers not having time to compensate post-winter, due to the trial period being 44 days shorter than 2011.

In terms of the leucaena-grass system, better weight gains were achievable, along with higher stocking rates, which meant costs could be spread across more animals. Establishing leucaena-grass pastures is a significant upfront investment, however this cost is spread over many years with minimal ongoing annual costs. As a legume, leucaena also fixes nitrogen which boosts pasture growth and contributes positively to the overall quality of the livestock's diet. In this trial, where the leucaena-grass paddocks were predominantly frost-free, cattle had constant access to green leaf and were able to gain weight during the winter.

Oats as a stand-alone system produced minimal returns, however when combined with leucaena-grass for six months preceding, it produced an annual return much greater than the grass-only system. The oats return was positively influenced by good weight gains. However, large annual costs, the need for a fallow period and relatively short feeding periods, impacted on the return negatively. The returns on the grain bin post each trial period were low, but enabled an increase in the annual return for the steers in that system as it allowed them to better meet market specifications.The Bannockburn feedlot was shown to be a cost-effective system, with good growth rates being achieved, costs being kept in check and steers able to consistently meet market specifications. It is worth noting that the Bannockburn feedlot costs are considered to be lower than industry average (see Appendix 10), thus partly contributing to its favourable outcome.

The data analysis also indicated it was sometimes necessary to assess both the big picture as well as some of the finer details. The trial groups' average performance does not tell the whole story. As many producers now regularly weigh steers and record individual performance, there is an opportunity to improve returns by tracking individual animal performance to understand why some perform better than others when higher inputs are being applied to the production system. The increased range of outcomes for individual steers within finishing systems appears to be a feature where increased inputs and costs are not matched by increased steer performance.

In this PDS, there was sufficient variation in steer performance across and within the finishing systems to suggest further investigation may provide better returns. For example, in both 2011 and 2012 the steers grazing leucaena-grass pastures displayed a much greater range in weight gain than those steers on grass-only, with the poor performing leucaena-grass steers significantly reducing the overall returns available from the system. This large spread suggests that certain steers were set back by eating leucaena and had they just eaten the grass component of the diet they would have likely improved their performance. The spread in performance of cattle grazing leucaena-grass was also reported in the Optimising Growth Pathways Project conducted by McLennan (2014). It is undetermined why this spread exists. Some would suggest it is due to an inadequate presence of the leucaena bug, however in this PDS, the toxin levels exhibited suggest performance should not have been affected.

However, it was concluded from this study that steer finishing systems similar to those practiced at 'Bannockburn' can improve both business production output and profitability when appropriately implemented and managed.

5.3.1 Alternative investment comparison

The annual returns achieved by the different finishing systems at 'Bannockburn' in 2011 and 2012 were compared with the returns which would have been achieved had the money tied up in the steers been invested in blue chip Commonwealth Bank (CBA) shares. In 2011, the return from CBA shares was 12.41%, which reflects the change in value of the shares along with the franked dividends. The annual returns on capital invested in livestock generated in the three high input systems (leucaena-grass, oats and feedlot) ranged from 22–31%,

implying that investing money in steers and running them under high input systems at 'Bannockburn' was a more profitable option. The annual return on the grass-only steers in 2011 was 14%, thus it was comparable with investing in shares.

In 2012, the result was markedly different, with the bank shares generating a 50% return. The high input systems were again profitable in 2012 (10–23% return), along with the system involving 10 head that ran on grass for six months and then entered the feedlot (28%). The grass system in the second year produced a –1% annual return, meaning it was an unprofitable option that year. While bank shares performed exceptionally well in 2012, it is recognised that they can also devalue significantly in other years.

5.3.2 Individual returns and rankings

Late in the project, the individual partial returns produced by the trial steers were investigated, along with the relationship between ADG and the financial partial returns. The percentage of leucaena-grass and grass-only steers that were in either the top or bottom 20 or 33% of their treatment group for individual return after the first period and then again at the end of the trial period, are shown in Table 6. In all four combinations (grass-only + grass-only and leucaena-grass + leucaena-grass for both 2011 and 2012), over 60% of the steers that were either top or bottom after period one maintained that ranking when the annual return was calculated. Given this, an opportunity exists to identify high and low performing animals based on their economic performance at strategic times, such as going into winter, retaining the profitable animals and selling the unprofitable ones. If a producer was to use a spreadsheet template such as that provided in Appendix 16 and know the costs of running a particular system e.g. grass-only or leucaena-grass, individual returns could be calculated by allocating an entry and exit price and knowing animal weights. Appendix 16 shows the method used for calculating individual first period returns for the grass-only steers in 2011.

As some producers may consider this approach complicated, the influence of weight gain on the individual partial return was explored. Twenty-four combinations of high and low ADG and the financial returns for the first and second period, along with the overall ADG, were assessed. In the majority of cases (19/24 combinations), 80% of the time, the high or low ADG matched the similarly high or low returns. The other five combinations produced a 60% or better result.

Given the above result, average daily gain was considered a major contributor to the individual returns produced, thus if producers continue to sell animals with a poor ADG they are generally heading in the right direction of removing unprofitable animals. Using actual individual partial returns to determine the most and least profitable animals however would be a more accurate way of improving the efficiency of the beef business.

5.3.3 Cost of gain

The costs factored into the grass-only and leucaena-grass figures included the amortised pasture development cost and the amortised cost of land. As the oats cattle received a share of a grain supplement at the end of grazing in 2011, this was factored into the costs, along with the oats pasture development cost. The feedlot costs were based on the feed only, with a feed conversion of 8.5 kg on an as fed basis. Labour and selling costs were excluded from all four scenarios, to reduce seasonal/regional variation in the analysis. The gain was the average number of kilograms achieved per head over 364 days on the grass-only and leucaena-grass, 105 days for the oats and 116 days for the feedlot.

The low COG for the leucaena can be explained by the high stocking rate (1 ha/head) over the course of the 364 days, along with the weight gain 0.7 kg/hd/day. However, COG doesn't specifically indicate profitability or show how profitable the finishing systems actually were.

For example, the COG for the feedlot was the highest at $2.04/kg yet when assessing the economic performance of the finishing systems using the partial return on livestock capital invested, feedlotting proved to be the most profitable finishing system in the second period of both years. When feedlotting was combined with leucaena-grass for six months preceding feedlot entry, the system produced the highest annual return in both 2011 and 2012. In summary, producers should take caution in using cost of gain to economically compare different finishing systems.

5.4 Diet quality

The crude protein of the leucaena-grass paddocks was generally higher than the grass-only paddocks. Crude protein levels generally followed the 'Bannockburn' rainfall (see Figures 6 and 7). Grazing pressure and stock movements were also shown to impact F.NIRS CP levels, with diet quality higher at the start of a rotation and lower at the end. Being above the frost line also meant that the leucaena retained some green leaf all year. The grass-only paddocks were about 50 m lower than the leucaena-grass paddocks and were subject to frost. This elevation difference was conscientiously brought to the attention of attendees at PDS activities. As mentioned in the Method (Section 3), the project team supported the decision of the co-operator and manager about the paddock selection based on the paddocks' ability to run the number of cattle involved in the trial and their convenience to the yards due to the need to regularly weigh cattle. Despite the elevation differences, this is considered to be commercial reality, as those who have planted leucaena in the Bell district, have tended to plant it on elevated country to avoid frost and grass is generally planted on lower country.

The first drop in CP levels in 2011(see Figure 7) was partially attributed to a dilution effect associated with extremely high rainfall. For the leucaena-grass cattle it was also due to the sample being taken at the end of a rotation period and the cattle having reduced selection opportunity.

Lower CP levels in both winters were due to below average rainfall, frost and the pasture grasses being in their mature phase. The 6% CP level in grass in successive winters contributed to the steers losing 0.25 kg/hd/day. A photo of the grass and steers in late August 2012 is shown in Appendix 17. Had the steers been fed a protein supplement while the crude protein was at this low level, a weight gain response would have been likely. The project team were approached by feed companies to test this assumption in 2012, however the decision was made not to supplement because the treatment groups were already at minimum numbers.

The leucaena retained green leaf during both winters which provided a higher protein diet and positive weight gains. In the winter of 2011, the leucaena-grass steers were only on a slightly better diet (7% CP), and this was reflected in their 0.1 kg/hd/day weight gain. In the winter of 2012, the leucaena-grass steers' diet contained 9% CP allowing them to put on 0.56 kg/hd/day. A photo of the leucaena-grass pastures and steers in late August 2012 is shown in Appendix 18.

A sharp decline in CP levels in early 2012 on both the leucaena-grass and grass-only was due to a dry, hot start to summer. The low CP% in the grass-only paddock in September 2012 is hard to explain given the weight gain of the grass-only steers was 0.9 kg/hd/day for the September-October period but could be due to compensatory growth coming out of winter.

The dry matter digestibility of the leucaena-grass paddocks was generally higher than the grass-only paddocks. In early 2011, leucaena-grass DMD was lower than the grass-only paddock, possibly due to the sample being taken from a paddock which was well utilised at

the end of a rotation period and diet selection was slightly restricted. Dry matter digestibility was lowest during winter with lower rainfall, frost prevalence and pasture maturity all contributing factors.

As predicted, the non-grass intake percentage was higher for cattle on leucaena-grass than for cattle on grass-only. There appears to be a trend for the grass-only cattle to increase browse in winter, presumably looking to supplement protein in their diet. With the steers on leucaena-grass, leucaena made up approximately 30% of the diet, with a range of 10–60%. The higher winter weight gain of 0.56 kg/hd/day in 2012 coincided with significantly more non-grass (leucaena) in the diet.

As expected, analysis showed that young oats was highly digestible and high in crude protein. While levels dropped with increasing maturity, digestibility and crude protein remained relatively high, enabling high cattle performance. A photo of the oats crop in mid-June 2012 is shown in Appendix 19.

5.5 Leucaena bug

An on-farm test kit was used to assess how well the leucaena rumen bug was circulating through each mob on leucaena-grass in each year. Only small numbers had their urine collected for analysis due to the time-consuming nature of collecting the samples and the limited time available in a commercial operation.

The yellow/straw colour of the samples taken at Week 10 in 2011 indicated that the bug was circulating. The slight orange colour in week 18, 2011 and week 13 in 2012 indicated that potentially some level of 3, 4-DHP was present, but it was unlikely to be above the threshold to be of concern. In discussions with personnel who have been involved in research relating to the leucaena bug and the test kit, this slight orange colour may be a result of there being an imbalance of leucaena to bugs just prior to testing, or additional compounds reacting with the ferric chloride.

In summary, the toxin levels displayed as a result of using the on-farm test kit suggest that performance (liveweight gain) should not have been affected in this demonstration.

5.6 Eating quality

It was hoped that all 187 trial steers would be MSA graded to determine if there were significant differences in meat quality due to the different feeding regimes. However this did not eventuate, with cattle being sent to the abattoir that provided the best financial returns irrespective of MSA licensing.

In late 2012 however, 35 steers which had been grazing on either leucaena-grass or grass-only for six months and then placed in the feedlot in June were graded at an MSA licensed abattoir. The end result was extremely positive, with 97% of the steers grading MSA with an average boning group of 6.8. Appendix 20 shows some of the 35 steers just prior to going to the abattoir. Given that the Ferriers now finish many of their steers using a similar finishing system i.e. leucaena-grass for six months over summer and autumn and then into the feedlot, they can be confident that they are capable of achieving high rates of MSA compliance and are in a position to benefit from receiving a premium for their product.

5.7 Extension activities and communications

The main activities for the PDS were field days. These days were extremely well received by attendees and this is reflected through feedback and on-farm practice change. Each field day had a range of guest speakers, many of whom spoke on topics suggested by

participants at previous field days. A photo of the guest speakers at the 2 December 2011 field day, along with the project team, in shown in Appendix 21. Participants valued the opportunity to network with fellow attendees and guest speakers during breaks and to view the trial paddocks in the afternoon. A photo of some field day attendees viewing a trial grass paddock in June 2011 is shown in Appendix 22. In addition to the field days, the Testing Management Options Workshop and the Stocktake App training session provided a great opportunity for a smaller group of producers to fine-tune their economic, spreadsheet and forage budgeting skills. Project objective three was met by conducting these more in-depth training opportunities, along with guest speaker Col Paton showcasing forage budgeting at the final field day.

5.7.1 Final field day

One hundred people attended the final field day held in April 2013 (Appendix 23). Attendees consisted of producers, agribusiness staff, government employees, consultants, researchers, company representatives and agricultural college students. This number and cross section of attendees reflected the interest generated by this PDS over time. Whilst many of the producers were locals, approximately 20 travelled more than three hours each way to attend. Feedback sheets revealed that ten businesses in attendance manage more than 1000 head of cattle each and five businesses manage less than 100 head each.

Attendees heard about the day through word of mouth, email, phone calls by DAF staff, MLA Friday Feedback, Queensland Country Life, local papers and the Leucaena Network Conference. This confirms that it is important to continue to use a range of methods to promote industry events.

To provide easy viewing of the trial results and detailed economic data, participants received a 23 page booklet at the field day. This booklet later became widely circulated throughout Queensland, with 50 copies picked up at industry events or requested via email/phone following media articles about the final field day.

The key messages from the final field day were also disseminated widely through numerous publications as demonstrated in Table 9. The PDS featured in the MLA Feedback magazine a number of times (Appendix 24).

5.7.2 Testing Management Options Workshop

At the Testing Management Options workshop conducted in September 2011, DAF staff guided participants through the spreadsheet-based herd economic modelling tool (Appendix 25). Eleven different scenarios were assessed; breeding and selling as weaners, feeders or bullocks, trading for varied time periods, agisting, growing oats and owning more land. When attendees commenced inputting their own figures that afternoon, they discovered the importance of keeping good business records and having an understanding of cattle weights at varying ages and performance on different feeding regimes. As expected, lack of scale quickly became apparent as a significant contributor to the unfavourable returns produced by each scenario. This activity received positive feedback and contributed greatly to meeting the fourth objective of this project.

5.8 Practice change

The PDS has had a positive influence on many Queensland beef producers since starting in late 2010 (see section 4.9). Field day feedback sheets have provided an insight into the number of producers who intend on making change as a result of seeing the project results and hearing guest speakers. Follow up phone calls and face-to-face conversations with the producer group 6-12 months after the final activity, have confirmed that practice change has taken place in their own businesses as a result of being involved in the PDS. Examples

include weighing cattle, keeping better records, planting leucaena, use of HGPs and use of the Stocktake App for pasture monitoring. The Ferriers and Steve Munge have also made management changes due to the PDS. Leucaena now has a pivotal role in backgrounding large numbers of steers before entry into the feedlot, no steers are run on grass-only pasture during the winter, and the feedlot is being used as an end point for all cattle. These changes provide evidence to support the success of the PDS in demonstrating the benefits of capturing objective data on the different finishing systems, as well as providing producers with useful information to make better decisions to increase their profitability.

5.9 Further Research

It is recommended that further research be conducted on understanding why some animals perform exceptionally well on high input finishing systems (leucaena-grass, oats and feedlot) or low input systems (grass-only) and others don't (see section 5.3). Gaining knowledge in the area would allow decisions on allocating animals to the various finishing systems to be made, thereby reducing financial risk and enabling more opportunity of financial benefit for producers.

It would be beneficial to determine the difference between the performance of leucaena-grass and grass-only paddocks with the same elevation and soil type (both above and below the frost line) and in drier years than that experienced at 'Bannockburn' in 2011 and 2012. Other areas of interest for the North-Eastern Downs region include: assessing alternative legume options to leucaena to see if they have a similar or better economic benefit; the economics of fertilising sown grass-only pastures; and trialling a range of protein supplementation options with steers grazing grass-only during winter. There is a clear need to further understand the potential productivity gains of the North-Eastern Downs region as the land is highly valued and if producers are to remain sustainable into the future, the profitability of their businesses will need to keep increasing.

6 Acknowledgements

The core team for the project included:

Tim Emery (Beef Extension Officer)
Roger Sneath (Beef Extension Officer)
Fred Chudleigh (Principal Policy Officer; Project Economist)
Ranald and Sally Ferrier (Property owners)
Steve Munge (Property manager)

We gratefully acknowledge Ranald and Sally Ferrier, along with Steve Munge, for hosting the demonstration at 'Bannockburn' and for taking the time and effort to be so heavily involved in the intensive data collection, economic analysis and field days. Thanks must also go to the producer group for attending activities and having input into the project's direction. All the field day speakers need to be congratulated on providing highly informative and influential presentations. Thanks to all the producers and industry personnel who attended the field days. Co-funding by Meat & Livestock Australia and in-kind support from the Department of Agriculture and Fisheries is graciously acknowledged.

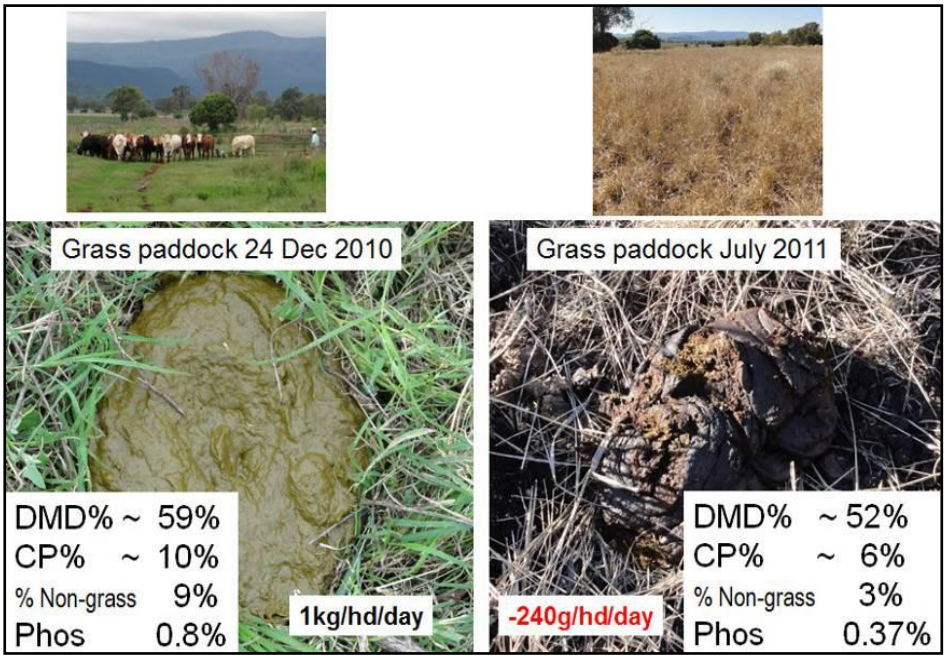
7 Appendices

7.1 Appendix 1

Purchased Simmental cross cattle for the 2012 trial period (~350 kg entry liveweight)

7.2 Appendix 2

A field day slide showing the difference in the grass, faeces, faecal analysis and weight gain in December 2010 and July 2011



7.3 Appendix 3

Leucaena-grass steer in spring 2011

7.4 Appendix 4

Steers after grazing leucaena-grass pastures for 320 days in 2012

7.5 Appendix 5

Grass-only steers in February 2012 gaining 1 kg/hd/day

7.6 Appendix 6

Summary of data used to generate returns for the grass-only feeding regime in the first period, 2011

Value added by grass pasture first period					
Number of steers at start				18	head
Number of hectares grazed				33.00	hectares
Number of days of grazing				202	
Initial weight of steers	12/11/2010	337	kg per head	6,059	kg
Steer value into grazing ($ /kg - on farm)				2.15	$ per kg live weight
Total steer cost		$723.71	per head	**$13,027**	
Final weight	2/06/2011	480	kg per head	8,641	kg
Weight gain		143	kg per head	2,582	kg
Weight gain per head per day				0.71	kg per head per day
Steer closing value ($ /kg - on farm)				1.85	$ per kg live weight
Total closing steer value		$888	per head	**$15,985.85**	
Value added to steers				$2,959.00	
Value added per head	$164	per head			
Costs attributed to grazing pasture					
Labour	$17	per head		$300	
Opportunity cost of steer capital	$20	per head		$360	
Amortised pasture development cost	$9	per head		$154	
Amortised cost of land	$71	per head		$1,278	
Total costs	$116	per head		$2,093	
Net value added to livestock capital	$48	per head		$865.92	
Partial return on livestock capital invested				6.65%	
Establishment cost of grass pasture				$120	per hectare
Life of pasture				20	years
Annual cost of pasture				$8.44	per hectare per annum
Value of grass pasture land				$2,000	per hectare
Opportunity cost of capital				3.50%	per annum
Labour				15	hours
				$20	per hour
Opportunity cost of steer capital				5%	

7.7 Appendix 7

Summary of data used to generate returns for the leucaena-grass feeding regime in the first period, 2011

Value added by leucaena-grass pastures first period					
Number of steers at start				69	head
Number of hectares grazed				134.00	hectares
Number of days of grazing				202	
Initial weight of steers	12/11/2010	343	kg per head	23,698	kg
Steer value into grazing ($ /kg - on farm)				2.15	$ per kg live weight
Total steer cost		$738.42	per head	**$50,950.70**	
Final weight	2/06/2011	517	kg per head	35,682	kg
Weight gain		174	kg per head	11,984	kg
Weight gain per head per day				0.86	kg per head per day
Steer closing value ($ /kg - on farm)				$1.85	$ per kg live weight
Total closing steer value		$957	per head	**$66,011.70**	
Value added to steers				$15,061	
Value added per head	$218	per head			
Costs attributed to leucaena grazing			**based on 365 days grazing**		
Labour	$4	per head		$300	
Opportunity cost of steer capital	$20	per head		$1,410	
Amortised pasture development cost	$11	per head		$769	
Amortised cost of land	$35	per head		$2,423	
Total costs	$71	per head		$4,901	
Net value added to livestock capital	$147	per head		$10,160	
Partial return on livestock capital invested				19.94%	
Costs attributed to leucaena grazing			**based on 300 days grazing**		
Labour	$4	per head		$300	
Opportunity cost of steer capital	$20	per head		$1,410	
Amortised pasture development cost	$14	per head		$936	
Amortised cost of land	$43	per head		$2,948	
Total costs	$81	per head		$5,593	
Net value added to livestock capital	$137	per head		$9,468.01	
Partial return on livestock capital invested				18.58%	
Establishment cost of leucaena				$390	per hectare
Life of leucaena pasture				20	years
Annual cost of leucaena pasture				$27.44	per hectare per annum
Value of land				$2,470	per hectare
Opportunity cost of capital				3.50%	per annum
Labour				15.00	hours
				$20	per hour
Percentage of leucaena grazing allocated to trial steers				37.79%	

7.8 Appendix 8

Summary of data used to generate returns for oats second period in 2011

Oats value added					
Number of steers at start				23	head
Number of hectares grazed				13.4	hectares
Number of days of grazing				105	
Initial weight of steers	2/06/2011	517	kg per head	11,881	kg
Steer value into grazing ($ /kg - on farm)				1.85	$ per kg live weight
Total steer cost		$955.65	per head	**$21,980**	
Final weight		597.13	kg per head	13,734	kg
Weight gain		80.57	kg per head	1,853	kg
				0.77	kg per head per day
Steer closing value ($ /kg - on farm)				1.94	$ per kg live weight
Total closing steer value		$1,158	per head	**$26,636**	
Value added to steers				$4,656	
Value added per head	$202	per head			
Costs attributed to oats grazing					
Labour	$10.43	per head		$240	
Selling and levy expenses	$25.00	per head		$575	
Opportunity cost of steer capital	$14	per head		$315	
Oats pasture development cost	$86	per head		$1,983	
Amortised cost of land	$39	per head		$894	
Total costs	$174	per head		$4,007	
Net value added to livestock capital	$28	per head		$649	
Partial return on livestock capital invested				2.95%	
Establishment cost of oats	$191.67	per hectare (contract rate)			
Opportunity cost of steer capital	5%				
Value of land	$2,470	per hectare			
Opportunity cost of capital	3.5%	per annum			
Labour	12	hours			
	$20	per hour			
Share of trial steers grazing oats	77.21%				

7.9 Appendix 9

Summary of data used to generate returns for the feedlot steers in the second period, 2011

Feedlot value added					
Number of steers at start				21	head
Number of hectares grazed				0	hectares
Number of days of grazing				116	
Initial weight of steers	2/06/2011	518	kg per head	10,878	kg
Steer value into grazing ($ /kg - on farm)				1.85	$ per kg live weight
Total steer cost				**$20,124**	**$958**
Final weight	23/09/2011	694	kg per head	14,531	kg
Weight gain		176	kg per head	3,653	kg
Weight gain per head per day				1.52	kg per head per day
Steer closing value ($ /kg - on farm)				$4.07	$ per kg dressed
Total closing steer value		$1,543	per head	**$32,394**	
Value added to steers				$12,269	
Value added per head	$584	per head			
Costs attributed to feedlot					
Feedlot cost (from feedlot worksheet)	$470.44	per head		$9,879	
Opportunity cost of steer capital	$15.23	per head		$320	
Total costs	$486	per head		$10,199	
Net value added to livestock capital	$99	per head		$2,070	
Partial return on livestock capital invested				10.29%	

7.10 Appendix 10

Additional feedlot worksheet for 2011

Feedlot Worksheet			
Days on feed			116
Number of head to be fed			21
Annual repairs and capital cost for feedlot	$0.15	per head per day	$365
Annual cost of labour + operating costs	$0.40	per head per day	$974
Livestock costs			
Average purchase price of fed animals ($ per kg live weight in paddock)			$1.85
Average entry weight of steers (kg live weight in paddock)			518
Daily gain (kg/day)			1.52
Number of days on feed (days)			116
Feed Requirement (% of liveweight consumed per day)			2.129
Total feed requirement (kg per head fed)			1497
Average sale price of fed animals ($ per kilogram dressed)			$4.07
Stock Loss (%)			0%
Annual Interest Rate (%)			6.00%
Commission (% of sale price)			0%
Cost of Feed ($/tonne including mixing costs and transport to property)			$238.36
Feed costs in $/head			$356.83
Other costs ($/hd)			
Freight in (if applicable)			$0.00
Freight out			$35.00
Interest on animal			$0.00
Interest on feed			$6.80
Commission			$0.00
Transaction levy			$5.00
Depreciation			$0.00
Repairs and capital costs per head fed			$17.40
Labour and operating cost per head fed			$46.40
Growth Promotants			$0.00
Vet Costs			$3.00
Other (yard dues,etc)			$0.00
Cost of stock losses			$0.00
Total feed and other costs per head fed			$470.44

7.11 Appendix 11

Range in individual returns of steers in the different finishing systems, 2011 and 2012

	First period return			Second period return		Annual Return (AR)	
	2011	2012		2011	2012	2011	2012
Leucaena-grass	3.9% - 31.1%	-4.6% - 26.2%	Leucaena-grass	-14.6% - 24.4%	1.5% - 13.1%	0.3% - 50%	5.3% - 30.6%
			Oats	-7.1% - 13.4%	-3.4% - 10.5%	4.9% - 43.4%	-4.5% - 27.9%
			Feedlot	-12.7% - 27.2%	1.3% - 22.2%	-2.5% - 52%	3.9% - 41%
Grass-only	-3.0% - 18.1%	-2.5% - 21.1%	Grass-only	-2.4% - 14.4%	-11.2% - -0.3%	5.2% - 30.5%	-11.1% - 9.5%

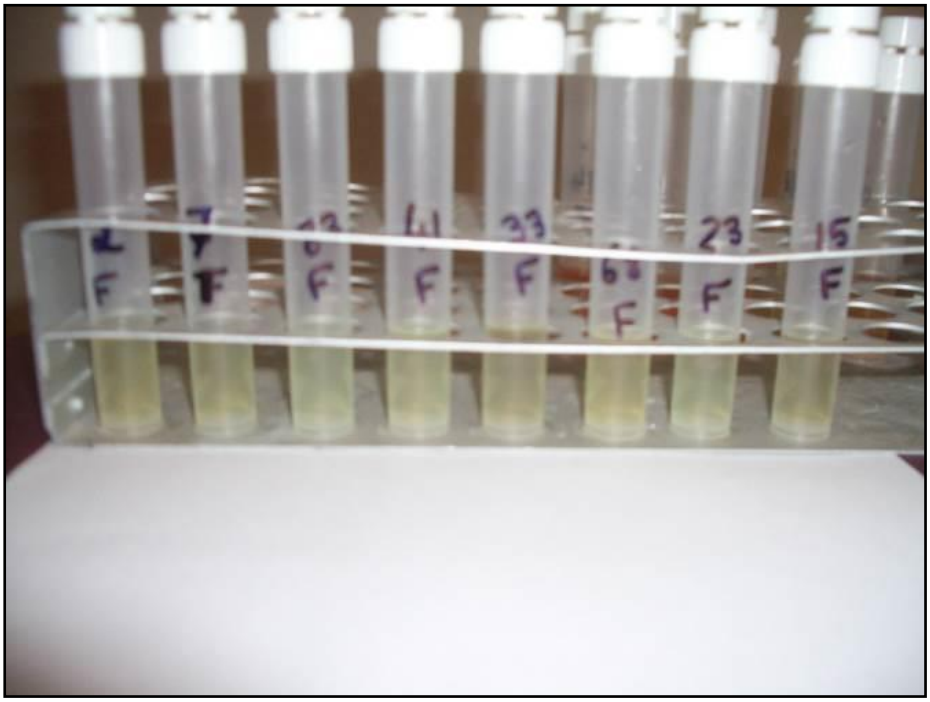
7.12 Appendix 12

Soil test results for a grass-only, leucaena-grass and oats paddock sampled in March 2011

		Grass 1 - Water tank Soil	Leucaena 4 - Top Soil	Dairy Oats Soil
ACIDITY				
pH - Water	pH units	6.05	6.53	6.65
MAJOR ELEMENTS				
Nitrate Nitrogen	mg/kg	2	2	23
Phosphorus - Colwell extr	mg/kg	141	46	85
Potassium	mg/kg	475	430	384
SECONDARY ELEMENTS				
Sulphur - KCl	mg/kg	1.7	2.6	3.7
Aluminium	mg/kg	1	1	1
Calcium	mg/kg	2730	1960	3860
Magnesium	mg/kg	415	427	981
TRACE ELEMENTS				
Boron	mg/kg	0.4	0.2	0.6
Copper	mg/kg	1.2	1.7	1.1
Iron	mg/kg	84	37	93
Manganese	mg/kg	70	35	36
Zinc	mg/kg	1.5	2.0	0.8
ORGANIC MATTER				
Organic Matter	%	3.6	3.7	3.3
SALINITY				
Electrical Conductivity	dS/m	0.03	0.04	0.09
Chloride	mg/kg	6	9	12
Sodium	mg/kg	43	40	174

7.13 Appendix 13

Urine samples obtained week 10 after inoculation in 2011; all samples remained yellow/straw coloured

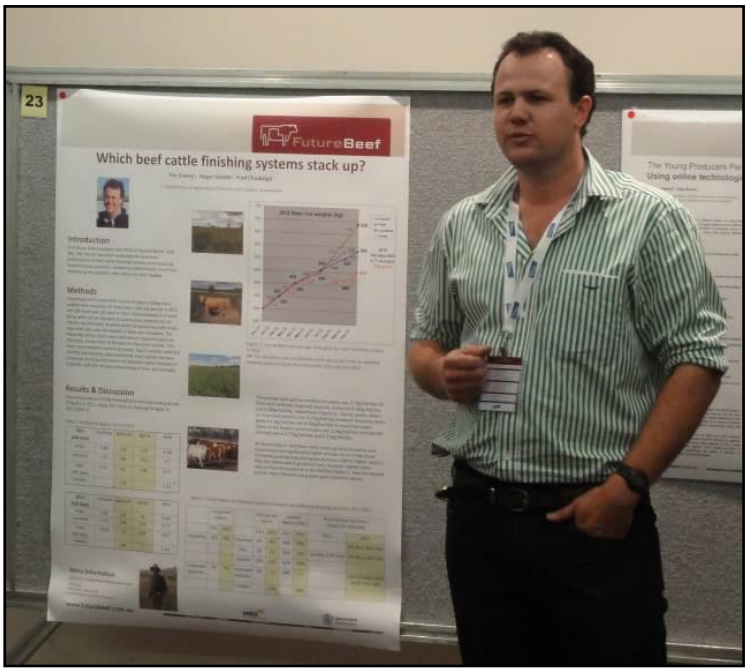


7.14 Appendix 14

Urine samples obtained week 18 after inoculation in 2011; six out of seven samples turned slightly orange

7.15 Appendix 15

Project leader, Tim Emery, presenting the PDS poster at NBRUC in August 2013



7.16 Appendix 16

Data involved in calculating the individual first period returns for the grass-only steers in 2011

		Start value						Opp. cost	Opp. cost	Labour and		Individual
		including				Closing	Gross	steer capital	Land and	treatment		return
	12/11/2010	freight in	2/06/2011			value	Value	5.00%	Pasture	costs	Value added	(Value added/
Mgt tag	Wt (kg)	$2.15	Wt (kg)	Wt gain/hd	ADG	$1.85	Added	per annum	$79.59	$17 per head	first period	Start Value)
32	279	$599.85	444	165	0.82	$821.40	$221.55	$16.60	$79.59	$17	$108.70	18.12%
85	311	$668.65	429	118	0.58	$793.65	$125.00	$18.50	$79.59	$17	$10.24	1.53%
20	330	$709.50	499	169	0.84	$923.15	$213.65	$19.63	$79.59	$17	$97.76	13.78%
29	332	$713.80	482	150	0.74	$891.70	$177.90	$19.75	$79.59	$17	$61.89	8.67%
10	360	$774.00	506	146	0.72	$936.10	$162.10	$21.42	$79.59	$17	$44.43	5.74%
38	331	$711.65	497	166	0.82	$919.45	$207.80	$19.69	$79.59	$17	$91.85	12.91%
67	345	$741.75	498	153	0.76	$921.30	$179.55	$20.53	$79.59	$17	$62.77	8.46%
82	362	$778.30	506	144	0.71	$936.10	$157.80	$21.54	$79.59	$17	$40.01	5.14%
17	285	$612.75	429	144	0.71	$793.65	$180.90	$16.96	$79.59	$17	$67.69	11.05%
86	283	$608.45	394	111	0.55	$728.90	$120.45	$16.84	$79.59	$17	$7.36	1.21%
44	383	$823.45	546	163	0.81	$1,010.10	$186.65	$22.79	$79.59	$17	$67.61	8.21%
16	355	$763.25	512	157	0.78	$947.20	$183.95	$21.12	$79.59	$17	$66.57	8.72%
24	390	$838.50	504	114	0.56	$932.40	$93.90	$23.20	$79.59	$17	-$25.56	-3.05%
42	342	$735.30	474	132	0.65	$876.90	$141.60	$20.35	$79.59	$17	$25.00	3.40%
62	362	$778.30	512	150	0.74	$947.20	$168.90	$21.54	$79.59	$17	$51.11	6.57%
14	388	$834.20	518	130	0.64	$958.30	$124.10	$23.08	$79.59	$17	$4.76	0.57%
64	316	$679.40	458	142	0.70	$847.30	$167.90	$18.80	$79.59	$17	$52.84	7.78%
9	305	$655.75	433	128	0.63	$801.05	$145.30	$18.15	$79.59	$17	$30.90	4.71%

7.17 Appendix 17

The grass-only steers on relatively poor quality feed in late August 2012

7.18 Appendix 18

Steers grazing leucaena-grass pastures late August 2012

7.19 Appendix 19

Drover oats crop in mid-June 2012

7.20 Appendix 20

Steers prior to slaughter in 2012 after having been on grass-only or leucaena-grass for six months then in the feedlot

7.21 Appendix 21

Dave McRae (QCCCE), Roger Sneath (DAF), Steve Munge (Property Manager), Stew Taylor (NAPCO), Fred Chudleigh (DAF), Tim Emery (DAF), Ranald and Sally Ferrier (Property Owners) at the 2 December 2011 field day

7.22 Appendix 22

Field day attendees being shown one of the grass paddocks on 3 June 2011

7.23 Appendix 23

Steve Munge addresses the 100 attendees at the final field day held on 26 April 2013

7.24 Appendix 24

Steve Munge on the front cover of the MLA Feedback magazine following the final field day

7.25 Appendix 25

Roger Sneath (DAF) explaining the process of the Testing Management Options Workshop

8 Bibliography

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