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Prepared by: Stuart Buck

Department of Agriculture,
Fisheries and Forestry

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Implementation of Producer Demonstration Sites to increase research adoption and practice change in Queensland

PDSQLD003 - Demonstrating the impacts of land preparation techniques on leucaena establishment and productivity

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Abstract

This project tested establishment techniques to improve the economics of Leucaena production in the Callide Valley district of Central Queensland. Rising input costs of fuel, chemical, fertiliser and labour are encouraging producers to improve establishment techniques while minimising associated costs. Ripping the soil prior to sowing Leucaena, and fully removing grass (rather than leaving strips) have been advocated as essential operations to improve establishment and early plant vigour, however recommendations have largely been based on anecdotal evidence and producer observations. This project found no production benefit to ripping prior to sowing on a cracking clay soil, however establishment and early growth was improved on a non-cracking clay soil. No production benefit was found to support fully removing grass compared to leaving grass in strips.

Executive summary

Leucaena-grass pastures in suitable landscapes can double cattle weight gain and triple economic returns (Bowen *et al* 2010), however establishment is expensive and prone to failure if recognised land management practices are not adequately adhered to (Shelton and Dalzell 2007). Rising input costs of fuel, chemical, fertiliser and labour are encouraging producers to improve establishment techniques while minimising associated costs.

Producer members of the Biloela CQ BEEF project group undertook comprehensive business and situation analysis to identify scope for improvement in their businesses. A common theme from this analysis has been the need to increase beef production, and a range of options and strategies have been developed including the utilisation of Leucaena. Many producers in the Biloela group have already planted Leucaena with a number wishing to extend these existing plantings. The key establishment options these producers wanted to investigate include whether to rip the Leucaena runs prior to planting, and whether to prepare strips versus full grass removal. The theory behind these options is to provide a better soil environment by having greater soil-water availability and limited impediments to root growth. This provides reduced establishment risk and vigorous, even growth during the establishment period, resulting in earlier and more productive grazing in the long term.

The objectives of this project were to:

1. Demonstrate the production and economic impacts of ripping prior to planting Leucaena.
2. Demonstrate the production impacts of either fully removing grass or in strips prior to Leucaena establishment.

Project activities occurred on two properties, ‘Drumburle’ and ‘Lawgi Station’ near Thangool (Callide Valley district). ‘Drumburle’ is utilised primarily as a breeding property whereas ‘Lawgi Station’ is utilised for growing and finishing.

Two separate sites in the same paddock at 'Drumburle' were monitored for the impacts of pre-sowing ripping on soil parameters and Leucaena growth. Site 1 was a deep loam soil on a creek flat whereas Site 2 was a shallower rocky soil on a narrow leaf ironbark rise. These sites were chosen to represent the general land types of the property. Soil moisture and nutrient measurements were taken prior to ripping then again at planting. Leucaena biomass samples were collected 4mths (prior to the first winter and frost), 13mths (prior to first graze) and 39mths after sowing to determine both short and long term impacts of ripping. Cattle were first introduced after the 2nd biomass sampling.

A positive soil water benefit to ripping was measured at 'Drumburle' and this is possibly due to improvements in water infiltration over the fallow period. There were no changes to any soil nutrient parameters due to ripping. Levels of essential nutrients for Leucaena production were adequate at both sites, however levels were higher in Site 1 compared to Site 2 and this supported higher Leucaena plant growth (about 1000kg/ha dry matter) at the end of the trial. Impacts of ripping on plant population (establishment) were measured prior to the first winter, about 4 months after sowing. Significant differences were recorded with higher plant population where the soil was ripped. Leucaena biomass yield (dry matter) was measured on 3 occasions; 4mths, 12mths and 3yrs after sowing. A significant dry matter difference was measured 4mths after sowing, however this difference disappeared by 12mths after sowing and similarly when measured 3yrs after sowing. This indicates on non-cracking soils the impact of ripping the soil prior to sowing Leucaena only provides short term plant establishment benefits, and no long term biomass yield and hence grazing value is provided. This establishment benefit, however, could be very significant. If by ripping a planting failure is averted, this could save the producer about $120/ha in planting costs and subsequent weed control to ensure successful re-planting.

Two separate sites in different paddocks at 'Lawgi Station' were monitored for the impacts of pre-sowing ripping. Both sites were on clay soils, one more cracking than the other, and were chosen to contrast with the soils at 'Drumburle'. Also in both paddocks and adjacent to each of the ripping trial sites, areas were allocated to investigate the impact of full grass removal on Leucaena growth, compared to leaving grass in strips.

Similar soil moisture levels were measured at planting in both sites at 'Lawgi Station', showing ripping a clay soil did little to improve soil moisture levels. Similar to the results obtained at 'Drumdurle', there were no or limited impacts on soil nutrients due to ripping. Another important observation at Site 2 was the large decrease in soil chloride levels between the sampling times. Rainfall during the fallow moved chloride down the top soil, significantly improving the soil environment for seed germination. However, this increased the chloride levels in the 10-45cm layer and subsequently retarded seedling growth and vigour. This finding will assist future soil type recommendations, as limited information is known about the chloride tolerance of Leucaena. The impacts of soil ripping on plant population was measured prior to the first winter, about 4mths after sowing. No significant difference was measured between the treatments at either site. Leucaena biomass yield (dry matter) was measured on 3 occasions; 4mths after sowing, 12mths after sowing and 27mths after sowing. Cattle were first introduced after the second dry matter assessment. No significant dry matter difference was measured 4mths after sowing at either site. The dry matter yield at Site 2 was very low due to high soil chloride levels, low plant population, slow plant growth and significant grazing pressure from wallabies and kangaroos. Due to the poor establishment and low prospects of recovery, it was decided to abandon this site. These results indicate that on a cracking clay soil very little benefit, either establishment or longer term plant production, occurs from ripping the soil prior to sowing.

Two trials at "Lawgi Station' investigated the soil water and dry matter impacts of grass removal. Trial areas were prepared exactly the same way as the ripping trial, however the grass strips that remained were sprayed twice during the fallow period, to replicate full grass removal. These trials were not replicated and so no statistical analysis could be performed. At Site 1, more soil water accumulated in the Leucaena row where the grass was sprayed compared to where it wasn't (in the ripping trial) however at Site 2 the opposite occurred. Due to the establishment issues at Site 2, dry matter yields were only measured at Site 1. While more soil water accumulated at Site 1, dry matter measurements indicate very little, if no difference had occurred either initially or longer term. The overall results from this comparison indicate more research is required to fully understand the impacts of full grass removal compared to leaving grass in strips.

The long term economics of ripping prior to sowing Leucaena were investigated using a net present value (NPV) analysis. The cost of undertaking the ripping operation by the co-operator has been calculated at $40/ha, due to low ownership cost (low replacement value), and low operating costs (fuel, repairs and maintenance) of the D5 bulldozer used to perform the ripping. As there was no difference in usage forage yield for cattle growth at either site at the end of the trial, we have assumed the same cattle production from both systems. A NPV analysis was performed over a 20yr period, and the NPV for plus rip is slightly lower than minus rip due to the extra costs incurred to rip the soil. But if the stocking rate could increase from 3ha/AE to 2.95ha/AE in the first year and from 2 to 1.95 from year 2 onwards, that would be enough to offset the costs of ripping.

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1 Background

Members of the Biloela CQ BEEF project group undertook comprehensive business and situation analysis to identify scope for improvement in their businesses. A common theme from this analysis has been the need to increase beef production, and a range of options and strategies have been developed including the utilisation of Leucaena. Many producers in the Biloela group have already planted Leucaena with a number wishing to extend these existing plantings. However rising input costs (fuel, fertiliser, chemical, labour) have many producers asking questions about establishment options to minimise costs and lost production time, yet ensure successful establishment.

Prior to this project, limited to no research evidence to support ripping prior to sowing Leucaena had been conducted, nor was there research evidence to support fully removing grass to improve the establishment and growth of Leucaena. Typically the recommendations of either establishment operation were anecdotal, and for ripping were largely based on findings from cropping systems.

The key establishment options these producers wanted to investigate include whether to pre-rip the Leucaena runs prior to planting; whether to prepare strips versus full grass removal.

The theory behind using these options (i.e. ripping and full grass removal) is to provide a better soil environment, by having greater soil-water availability and limited impediments to root growth. This provides reduced establishment risk (failure) and vigorous, even growth during the establishment period, resulting in earlier and more productive grazing in the long term.

Establishment costs are a significant barrier to the adoption of Leucaena primarily due to the high initial cost outlay and the potential long payback period on this investment (up to 5 years), plus the potential for establishment failure. Even when this cost is proportioned over a 30 year investment period, producers need to minimise the risks associated when establishing Leucaena.

Planting Leucaena after fully removing grass (in an existing pasture situation) can cost $425/ha, whereas removal of grass in strips reduces costs to around $334/ha. Added to this, ripping prior to planting will add another $75-$100/ha depending on the row spacing and machine used. Therefore strip planting without ripping offers significant cost savings. However the effectiveness of establishment and risks with retaining grass and not ripping have not been scientifically quantified. Do competitive grasses such as Buffel take moisture from young Leucaena and slow development? Does ripping provide an environment for quicker growth hence earlier grazing?

This PDS project aimed at demonstrating the impact of establishing Leucaena with or without pre-ripping, and strip preparation or full grass removal.

2 Project objectives

1. Demonstrate the production and economic impacts of ripping prior to planting Leucaena.

2. Demonstrate the production impacts of either fully removing grass or in strips prior to Leucaena establishment.

3 Methodology

Project activities occurred on two properties, 'Drumburle' and 'Lawgi Station' near Thangool (Callide Valley district). Both are owned and operated by the Barrett family. 'Drumburle' is primarily utilised as a breeding property whereas 'Lawgi Station' is utilised for growing and finishing. A group of local producers (Appendix 2) participated in the development and activities of the project

3.1 'Drumburle' sites

Two separate sites in the same paddock at 'Drumburle' were monitored for the impacts of pre-sowing ripping on soil parameters and Leucaena growth. Site 1 was a deep loam soil on a creek flat whereas Site 2 was a shallower rocky soil on a narrow leaf ironbark rise. These sites were chosen to represent the general land types of the property. Both sites were in A land condition with high ground cover of 3P grasses, no weeds and no evidence of significant erosion or woodland thickening. Both sites contained a range of both native (various Bluegrasses (*Bothriochloa* spp), Black spear grass (*Heteropogon contortus*), limited introduced grasses (Buffel (*Cenchrus ciliaris*), Green panic (*Panicum maximum* var. *trichoglume*)), Red Natal (Melinis repens)), and low-moderate amounts of other legumes (Shrubby stylo (*Stylosanthes scabra*) and Siratro (*Macroptilium atropurpureum*)) which were broadcasted many years ago by air.

Ground preparation for the paddock, and hence both sites, started July 2008 where strips 3-4m wide, 6m apart were cultivated into the existing pasture. Primary cultivation with Yeomans plough was conducted first, then offset and cultivator to prepare a seedbed (see table 1 for a list of operations conducted). Trial plots were marked out in each site, where treatments of plus rip and minus rip were randomly allocated and replicated three times (see appendix 1 for an example site plan). Benchmark soil water and nutrients were measured with a soil coring machine to 80cm soil depth to provide a baseline. Soil ripping was then undertaken in the middle of the cultivated strip with a D5 dozer with two tynes, about 1m apart to a depth of 65-70cm. The aim was to rip the soil where the Leucaena was to be subsequently planted.

Planting occurred at both sites late January 2009 with a 3-point-linkage disc opener planter. The variety Cunningham was sown at a rate of about 3kg/ha in twin row (1m apart). Weed control using Spinnaker and Round-up was undertaken post-planting, pre-emergence. Post-emergent grass weed control was undertaken with a selective grass herbicide, and 'beetle bait' was also spread across the planted rows soon after emergence to control above ground soil insects. No fertiliser was applied.

Soil moisture and nutrient measurements were again taken at planting. Leucaena biomass samples were collected four months (prior to the first winter and frost), 13 months (prior to first graze) and 39 months after sowing to determine both short and long term impacts of ripping. Cattle were first introduced after the second biomass sampling, then rotationally grazed thereafter.

3.2 'Lawgi Station' sites

Two separate sites in different paddocks at 'Lawgi Station' were monitored for the impacts of pre-sowing ripping on soil parameters and Leucaena growth. Both sites were on clay soils, one more cracking than the other, and were chosen to contrast the soils at 'Drumburle'. Site 1 was a deep, well structured brown cracking clay whereas Site 2 was a deep, harder setting grey clay. Both were typical soils for the property and commonly found in a Brigalow ecosystem, and were in A land condition with high ground cover of 3P grasses, no weeds and no evidence of significant erosion or woodland thickening. Both sites were

predominately grassed with Buffel, and Site 2 also contained some Shrubby Stylo in areas where the surface soil was loamier and contained some sand particles.

Ground preparation for both paddocks (and hence these sites) started around July 2009, one year after the 'Drumburle' sites. Exactly the same land preparation operations (type and number) was used as at 'Drumburle', however strips 3-4m wide were prepared on 8m centres rather than 6m (see table 1 for details). Treatments of plus rip and minus rip were allocated randomly and replicated three times at each site. The same soil and plant sampling regime was also used, as was the sampling timing.

In both paddocks and adjacent to each of the ripping trial sites, areas were allocated to investigate the impact of full grass removal on Leucaena growth, compared to leaving grass in strips. In both areas, three grass strips were sprayed twice with Round-up during the fallow period (between strip preparation and planting) to replicate full grass removal. This then provided 2 cultivated strips where Leucaena was sown to measure biomass and compare to the Leucaena sown in the ripping trial areas. The reason for spraying rather than cultivating was to minimise future operations and cost to re-seed grass, as it was anticipated the grass would re-grow from the existing soil seed bank.

Leucaena (Cunningham) was planted at both sites in early February 2010 at a sowing rate of about 3kg/ha in a twin row (1m apart). Weed control using Spinnaker and Round-up was undertaken post-planting, pre-emergence. Post emergent grass weed control was undertaken with a selective grass herbicide, and 'beetle bait' was also spread across the planted rows soon after emergence. No fertiliser was applied.

Cattle were introduced into Site 1 after the 2nd biomass measurement, about 14mths after sowing, and then rotationally grazed thereafter. Due to very poor establishment in both the ripping and spray area in Site 2, these trials were abandoned at the first biomass assessment.

3.3 Communication activities

A number of communication and adoption activities were held during the project which attracted a number of participants from a range of industries including agri-business, catchment management, banks, government extension and landholders. These communication activities are listed in Table 1.

Table 1. Communication activities during the project

What	When	Where	Number	Content
Field day	June 2010	Drumburle	50 producers and industry	Trial results, paddock walk
Leucaena Network Conference and Field day	October 2010	Biloela & Drumburle Lawgi Station	50 producers 6 producers	Trial results, paddock walks
Magazine article	January/February 2011	Feedback (MLA)		Trial results
Magazine article	September 2009	CQBEEF (DAFF)		Trial results
Reef and beef day	June 2011	Taroom	80	Trial results
NBRUC Conference poster paper	August 2011	Darwin		Trial results
AgForce branch meeting	September 2011	Moura	20	Trial results
Pasture information day	November 2011	Baralaba	45	Trial results
Leucaena variety launch (Wondergraze)	December 2011	Banana	90	Trial results
Leucaena information day	March 2012	Nebo	35	Trial results
Leucaena information day	March 2012	Wandoan	25	Trial results
Beef 2012 seminar	May 2012	Rockhamton	180	Trial results
Group meeting	June	Biloela	6	Trial results
Leucaena network conference	August 2012 (postponed)	Rockhampton		Trial results

4 Results and discussion

4.1 Paddock operations and associated costs

The number of paddock operations and the costs associated with the establishment of Leucaena are dependant on the soil type, initial land use, the equipment available and whether contractors are used as opposed owner-operation. At both properties a number of tillage operations were conducted to adequately prepare the seedbed as all sites were in existing pasture (Table 2). At each site on both properties the same operations were conducted. From discussions with numerous other Leucaena growers the methods and number of operations used here were typical. Producers wishing to do less need to be aware of the increased establishment risk implications through a poorly prepared seedbed.

Table 2. List of paddock operations and costs associated with establishing Leucaena at 'Drumburle' and 'Lawgi Station'

					Plus rip	Minus rip
Fallow Operations	Machine / product	Nos/kg/L	Cost/ha/L/kg	Area treated	Total cost/ha	Total cost/ha
Primary Cultivation	Yeomans	2	35	0.5	35.00	35.00
Secondary Cultivation	Yeomans (sweeps)	2	35	0.5	35.00	35.00
Secondary Cultivation	Offset	2	30	0.5	30.00	30.00
Weed control	Boomspray	1	6.2	1	6.20	6.20
	Roundup	1.2L	4.5	0.6	3.24	3.24
	2,4D	0.4L	6.8	0.6	1.63	1.63
Deep rip	D5	1	80	0.5	40.00	0.00
Cultivation	Scarifier & harrows	1	25	0.5	12.50	12.50
					163.57	123.57
Planting Operations						
Planter	Disc opener	1	23	0.5	11.50	11.50
Seed	Cunningham seed	3kg	12	1	36.00	36.00
Insect control	Lorsban powder	0.1kg	77	1	7.70	7.70
Beetle bait	Spreader	1	7.6	1	7.60	7.60
	Lorsban/grain	1L/40kg	17.2	1	17.20	17.20
Weed control	Boomspray	1	6.2	1	6.20	6.20
	Roundup	1.2L	4.5	0.6	3.24	3.24
	Spinnaker	0.14kg	700	0.6	58.80	58.80
					148.24	148.24
In-crop operations						
Weed control	Boomspray	1	6.2	1	6.20	6.20
	Verdict	0.25L	90	0.6	13.50	13.50
					19.70	19.70
Total Cost/ha					**331.51**	**291.51**
Total Cost/acre					**134.16**	**117.97**

Intensive soil cultivation such as ripping is relatively expensive due to high hourly fuel use and low work rate (hectares/hour). Due to the co-operator of this project already owning an older, medium sized bulldozer the cost to rip the soil per hectare is relatively low. However if a contractor was paid to do the same operation, the cost would be significantly higher (over $100/ha) depending on the size of the machine and work rate. Therefore, a producer who wishes to have the soil ripped prior to sowing Leucaena but needs to pay a contractor will need to assess the overall cost of the operation to ascertain if the benefits are worth the expense.

4.2 Soil and plant data from 'Drumburle'

Soil water and nutrients were measured prior to ripping, and then again at planting (about 3 months later). Between sampling times about 300mm of rain fell. At planting, more soil moisture was measured where the soil was ripped compared to where the soil wasn't (Figures 1 and 2). At Site 1 soil water actually decreased at planting where the soil wasn't ripped, whereas there was very little difference where the soil was ripped. At Site 2, very little difference in soil water occurred where the soil wasn't ripped, however where it was soil moisture increased. Overall, there was a positive soil water benefit to ripping and this is possibly due to improvements in water infiltration over the fallow period.

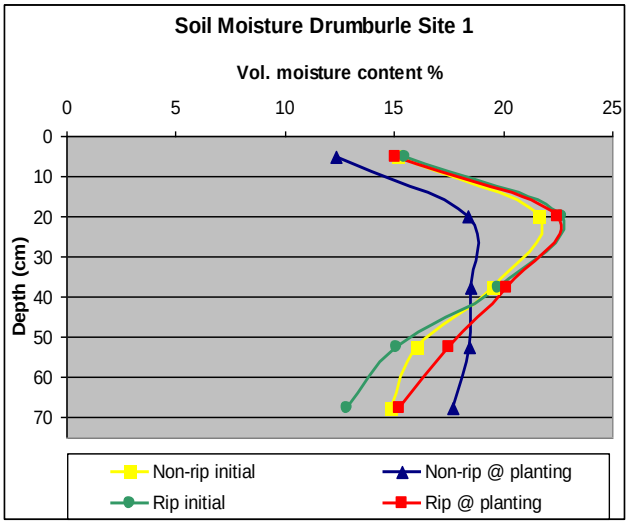


Figure 1. Soil water at 'Drumburle' Site 1

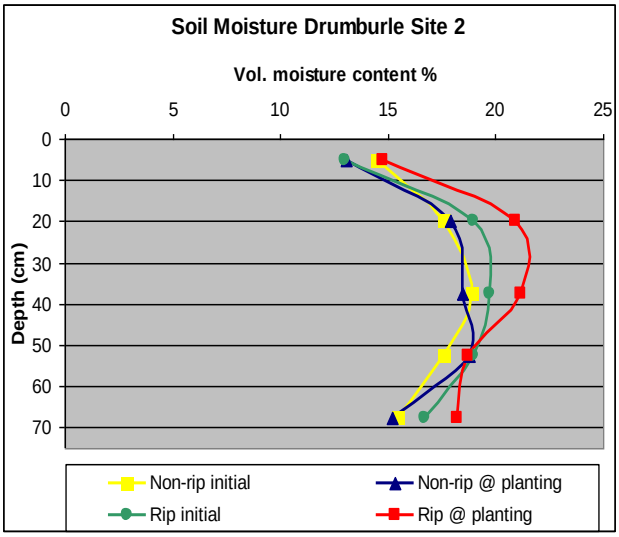


Figure 2. Soil water at 'Drumburle' Site 2

While a soil water difference was measured, there were no changes to any soil nutrient parameters due to ripping (Table 3). This result is perhaps not surprising due to the top soil layers (0-10cm) being cultivated numerous times in both treatments, and so the addition of one rip operation in the ripped plots has limited impact on soil nutrient release. Also, ripping did not change the availability of nitrogen (NO3-N or NH4) and sulfur (S) in the subsoil (10-80cm, the depth of ripping) (data not shown). Again this result is not surprising as nitrogen and sulfur are released from the decomposition of organic matter, of which is naturally very low in the subsoil. Also, one rip operation has limited impact of subsoil organic matter decomposition.

Levels of essential nutrients for Leucaena production were adequate at both sites, particularly phosphorus (P), sulfur (S) and zinc (Zn). However levels are higher in Site 1 compared to Site 2, indicating higher Leucaena plant growth and production potential.

Table 3. Soil nutrients (0-10cm soil layer) at 'Drumburle' Site 1 and Site 2 before and after ripping

Site	Sampling time	Treatment	P (mg/kg)	S (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Fe (mg/kg)	NO3-N (mg/kg)
1	Pre Rip	Plus rip	42	5	2	1	30	48	4
	At plant	Plus rip	47	5	2	1	30	48	8
	Pre rip	Minus rip	34	5	2	1	25	49	4
	At plant	Minus rip	47	5	2	1	32	45	7
2	Pre rip	Plus rip	18	4	2	1	28	28	3
	At plant	Plus rip	27	4	2	1	34	34	16
	Pre rip	Minus rip	16	4	2	1	29	28	4
	At plant	Minus rip	24	5	2	1	25	33	10

Impacts of soil ripping on plant population were measured prior to the first winter, about 4 months after sowing. Significant differences were recorded, with higher plant population in plots where the soil was ripped (Table 4). Leucaena biomass yield (dry matter) was measured on 3 occasions; 4mths after sowing, 12mths after sowing and 3yrs after sowing. A significant dry matter difference was measured 4mths after sowing, however this difference had disappeared by 12mths and 39mths after sowing (Table 4). This indicates that on these soils types (loam and shallow rocky) the impact of ripping the soil prior to sowing Leucaena provides a short term plant establishment benefit that does not translate to a long term yield increase and hence grazing value. This establishment benefit however, can be very significant. Leucaena has been noted to be difficult to establish with many producers experiencing establishment failures. Some have even experiences multiple failures, and causes are generally low viability seed, poor soil moisture or seed placement, adverse climatic conditions at planting or poor soil insect control. If by ripping more soil moisture is made available resulting in higher plant establishment and quicker earlier growth, this can significantly reduce the riskiness of Leucaena establishment. If a planting failure is adverted through the application of ripping, this could save the producer about $120/ha in planting costs and subsequent weed control to ensure successful re-planting.

Table 4. Plant population and Leucaena dry matter yields at 'Drumburle'

Paddock	Treatment	Plant pop (plants/m of row)	Dry matter 4mths after sowing (kg/ha)	Dry matter 13mths after sowing (kg/ha)	Dry matter 39mths after sowing (kg/ha)
1	Plus rip	14.2a	533a	1123a	2412a
1	Minus rip	9.7b	306b	1089a	2230a
2	Plus rip	12.8a	302a	1057a	1332a
2	Minus rip	10.7b	173b	824a	1385a

Treatment means followed by the different letters are significantly differently from each other.

Of note are the relative dry matter yield differences between Site 1 and 2 at the final (39mth) sampling. Both sites had been spelled for over 6 months prior to yield measurement, so these yields would represent the highest amount of Leucaena yield possible over a full spring and summer season. Site 1 recorded about 1000kg/ha more Leucaena yield, presumably due to the better soil in this paddock. While not measured, visual characterisation of the paddocks gives evidence that the creek flat contained less rock, more clay and possessed a deeper usable soil profile when compared to Site 2 being higher up the ridge. These observations support the current recommendation of sowing Leucaena on the best soil possible to maximise forage yield.

4.3 Soil and plant data from ripping trial at 'Lawgi Station'

Soil moisture was measured prior to ripping and then again at planting in both sites. Soil moisture levels were measured at planting in both sites, showing that ripping a clay soil did little to improve soil moisture levels (Figures 3 and 4). This indicates water infiltration wasn't improved during the fallow by ripping, possibly due to the cracking nature of this soil allowing water to enter the profile. It is noted though that at Site 2, soil water at 20cm of depth was slightly higher at planting. This could be due to the propensity of this soil to set hard and seal on the surface, meaning that the opening up the soil with a ripper tyne slightly improved water infiltration.

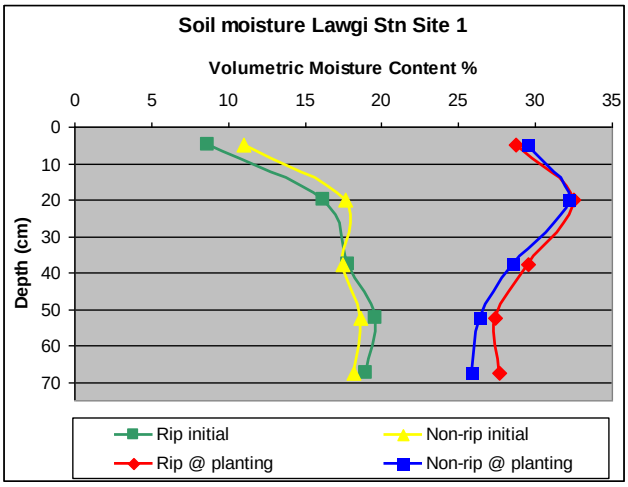


Figure 3. Soil moisture at Lawgi Station Site 1

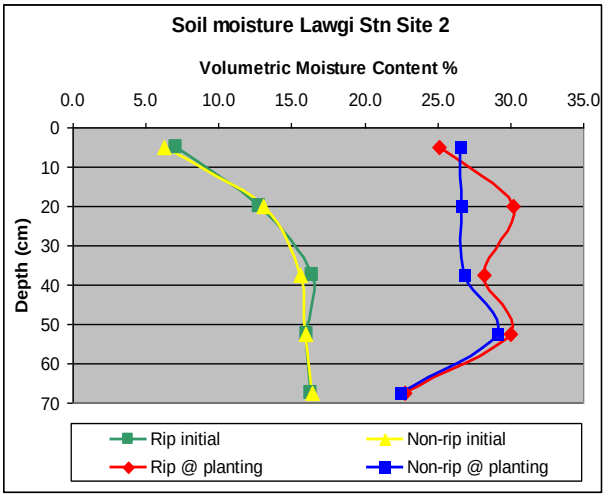


Figure 4. Soil moisture at Lawgi Station Site 2

Soil nutrients were measured prior to ripping and then again at planting at both sites. Similar to the results obtained at 'Drumburle', there were no or limited impacts on soil nutrients due to ripping (Table 5). The availability of some nutrients increased between sampling times (e.g. NO3-N, S), however this occurred in both treatments and thus was likely to be due to the multiple cultivation operations applied during the fallow to prepare the seedbed.

Table 5. Soil nutrients (0-10cm soil layer) at 'Lawgi Stn' Site 1 and Site 2 before and after ripping

Site	Sampling time	Treatment	P (mg/kg)	S (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Fe (mg/kg)	NO3-N (mg/kg)	Chloride (mg/kg)
1	Pre rip	Plus rip	50	10	3.3	1.1	81	17	1	43
	At plant	Plus rip	56	37	3.2	0.6	93	17	2	54
	Pre rip	Minus rip	52	9	3.5	0.8	86	18	1	22
	At plant	Minus rip	73	10	3.6	0.8	107	22	2	66
2	Pre rip	Plus rip	27	12	2.5	1.4	33	9	1	160
	At plant	Plus rip	32	13	2.5	1.0	23	8	4	45
	Pre rip	Minus rip	33	18	2.9	1.6	32	10	1	193
	At plant	Minus rip	27	29	2.6	0.9	24	9	6	96

Another important observation at Site 2 is the large decrease in soil chloride levels between the sampling times (Table 5). Chloride is a toxic salt that's water soluble in the soil, and it's apparent that rainfall during the fallow has decreased levels in both treatments in the top (0-10cm) layer. However ripping may have further decreased chloride levels in the upper soil layers but elevated levels in the subsoil (Table 6). Overall movement of chloride to the deeper layers has significantly improved seed germination, however the elevated chloride level in the 10-45cm layer has retarded seedling growth and vigour. As discussed further below, this is likely to be the cause of the observed ill-thrift at this site, and is why recovery was unlikely thus validating the reason to abandon this site.

Table 6. Chloride levels pre-rip and at planting Site 2 'Lawgi Station'

Site	Treatment	Depth	Chloride Pre rip (mg/kg)	Chloride at Planting (mg/kg)
2	Plus rip	0-10	160	45
		10-45	880	727
		45-75	1,467	1,833
	Minus rip	0-10	193	96
		10-45	863	803
		45-75	1,433	1,533

The impacts of soil ripping on plant population was measured prior to the first winter, about 4mths after sowing. No significant difference was measured between the treatments at either site (Table 7). Leucaena biomass yield (dry matter) was measured on 3 occasions; 4mths after sowing, 12mths after sowing and 27mths after sowing. No significant dry matter difference was measured 4mths after sowing at either site (Table 7). The dry matter yield at Site 2 was very low due to high soil chloride levels, low plant population, slow plant growth and significant grazing pressure from wallabies and kangaroos (see appendix 9.3 for a photo). Due to the poor establishment and low prospects of recovery, it was decided to abandon this site. At Site 1, a dry matter difference was measured at 12mths after sowing, and it's assumed ripping provided a better soil environment for Leucaena roots to explore into the subsoil, enabling higher above ground growth. This difference had disappeared 27mths after sowing (table 6). These results indicate that on a cracking clay soil very little benefit, either plant establishment or longer term plant production, arises from ripping the soil prior to sowing.

Table 7. Plant population and dry matter yields from 'Lawgi Station'

Site	Treatment	Plant pop (plants/m of row)	Dry matter 4mths after sowing (kg/ha)	Dry matter 12mths after sowing (kg/ha)	Dry matter 27mths after sowing (kg/ha)
1	Plus rip	13.6a	246a	1320a	113a
1	Minus rip	12.9a	245a	1205b	128a
2	Plus rip	4.1a	30a	na	na
2	Minus rip	4.1a	24a	na	na

Treatment means followed by the different letters are significantly differently from each other.

4.4 Soil and plant data from grass removal trial at 'Lawgi Station'

Two trials investigated the soil water and dry matter impacts of grass removal. Trial areas were prepared exactly the same way as the ripping trial areas, however the grass strips that remained were sprayed twice during the fallow period, to replicate full grass removal (see appendix 9.3 for a photo of sprayed grass strips). These trials were not replicated and so no statistical analysis could be performed. At Site 1, more soil water accumulated in the Leucaena row where the grass was sprayed compared to where it wasn't (in the ripping trial) however at Site 2 the opposite occurred (Figures 5 and 6). This result is surprising as the spray was effective at both sites. The soil type at Site 1 was uniform across both areas (ripping and spray trial area) however there were differences in top soil texture at Site 2, where the spray trial area visually contained more loam and sand particles compared to the ripping trial area.

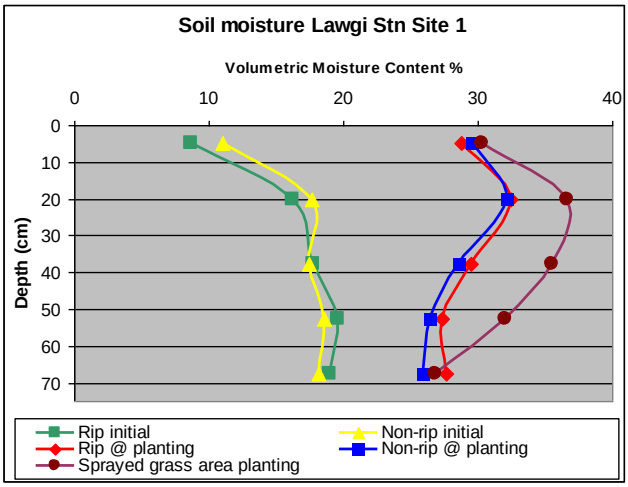


Figure 5. Soil water sprayed grass Site 1

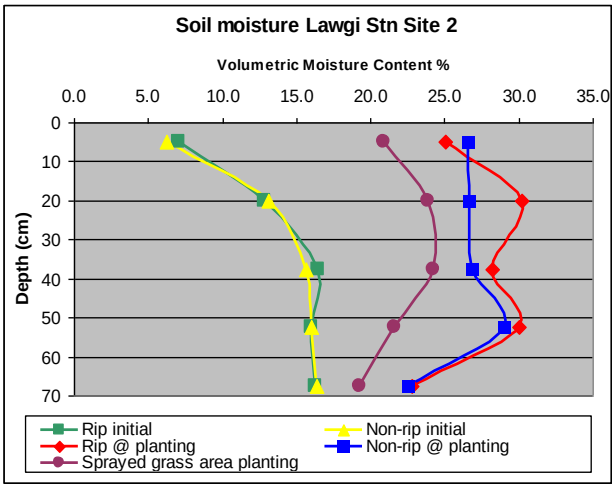


Figure 6. Soil water sprayed grass Site 2

Due to the establishment issues at Site 2, dry matter yields were only measured at Site 1. While more soil water accumulated at Site 1, dry matter measurements indicate very little, if no difference, either initially or longer term (Table 8). The overall results from this comparison indicate more research is required to fully understand the impacts of full grass removal compared to leaving grass in strips.

Table 8. Plant population and drymatter yields from grass removal trial at 'Lawgi Station'

Site	Treatment	Plant pop (plants/m of row)	Dry matter 4mths after sowing (kg/ha)	Dry matter 12mths after sowing (kg/ha)	Dry matter 27mths after sowing (kg/ha)
1	Plus rip	13.6a	246a	1320a	113a
1	Minus rip	12.9a	245a	1205b	128a
1	Sprayed grass	12.1	263	1260	132

4.5 Long term economics of ripping prior to sowing Leucaena

The cost of undertaking the ripping operation by the co-operator has been calculated at $40/ha, due to low ownership cost (low replacement value), and low operating costs (fuel, repairs and maintenance) of the D5 bulldozer used to perform the ripping. As there was no difference in usable forage yield for cattle growth at either site at the end of the trial, we have assumed the same cattle production from both systems. A net present value (NPV) analysis was performed over a 20yr period, and this indicated that the NPV for plus rip is slightly lower than minus rip due to the extra costs incurred by ripping the soil (Table 9). If should be noted however that if the stocking rate could increase from 3ha/AE to 2.95ha/AE in the first year and from 2 to 1.95 from year 2 onwards, that would be enough to offset the costs of ripping.

Table 9. Net present value (NPV) comparison of ripping versus no ripping

	NPV ($/ha)
Plus rip	14,739
Minus rip	15,059

5 Success in achieving objectives

This project has demonstrated the production and economic impacts of ripping prior to planting Leucaena. Outcomes from this project show little Leucaena benefit from ripping the

soil prior to sowing on a cracking clay soil, however an important establishment benefit was obtained when ripping occurred on a non-cracking soil.

This project did not find benefits from fully removing grass (compared to leaving grass strips) prior to sowing Leucaena. However it must be considered that this finding was concluded from one trial in a single year, and further research is required to provide more definitive conclusions.

6 Impact on meat and livestock industry – Now and in five years time

Prior to this project, limited to no research evidence to support ripping prior to sowing Leucaena had been conducted, nor was there research evidence to support fully removing grass to improve the establishment and growth of Leucaena. Typically the recommendations of either establishment operation were anecdotal, and for ripping were largely based on findings from cropping systems. While this project does have limitations, for example limited number of sites and seasonal conditions, the statistical analysis of the ripping trials does provide some confidence for producers to utilise these findings.

The adoption of these findings will be largely based around individual producer's belief of the benefits of ripping or full grass removal on their property, the equipment available to them and the costs associated undertaking these operations. There is no question ripping the soil or fully removing grass will incur significantly higher costs compared to not ripping or only removing grass in strips. This project didn't show any economic advantage (based on more forage growth) of doing either. However this project showed ripping the soil provided advantages in non-cracking soils, and these establishment advantages (higher plant population and quicker earlier growth) could prove in-valuable in years where rainfall is average or below.

7 Conclusions and recommendations

This project successfully met the objectives of demonstrating the production and economic impacts of ripping prior to sowing Leucaena, and the production impacts of fully removing grass compared to leaving grass in strips. No production or economic benefit was found to support ripping on a cracking clay soil 27 months after sowing, however improvements in plant establishment and early vigour were found on a non-cracking clay soil. No production benefits were found to support the concept that fully removing grass improves Leucaena establishment and plant growth from sowing to 2 years of age, however this conclusion was generated from only one trial site. More research is required to fully ascertain the impacts of fully removing grass compared to leaving grass in strips, and this research is needed to be undertaken across a range of seasonal conditions and soil types. In the mean time it's suggested these findings be further extended to ensure producers are making appropriate decisions based on the latest findings.

8 Bibliography

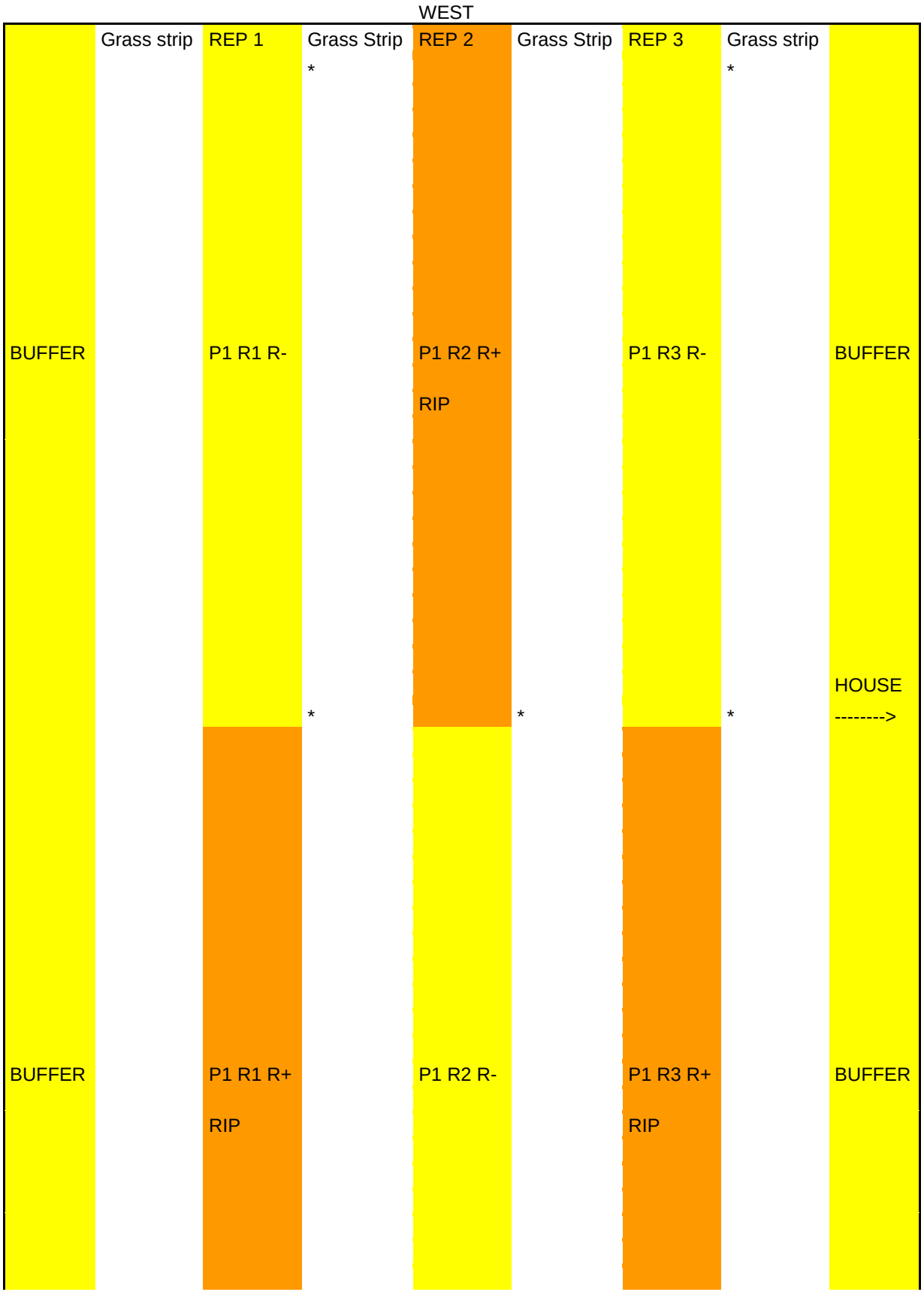
Bowen M, Buck S, and Gowen R. (2010). High output forage systems for meeting beef markets - phase 1. Final project report (B.NBP.0496). Meat and Livestock Australia, Sydney Australia.

Shelton M and Dalzell S. (2007). Production, economic and environmental benefits of Leucaena pastures. Tropical Grasslands. Vol 41, 174-190.

9 Appendices

9.1 Appendix 1

Trial layout at 'Lawgi Station' Site 1



row Nos 17		row Nos 16		row Nos 15	*	row Nos 14		row Nos 13	

Spray trial layout 'Lawgi Station' Site 1

Grass strip unsprayed		Grass strip SPRAYED	Cultivated	Grass Strip SPRAYED	Cultivated	Grass Strip SPRAYED	Cultivated	Grass strip unsprayed	
	Cultivated		Cultivated STRIP TO SAMPLE		Cultivated STRIP TO SAMPLE		Cultivated		HOUSE -------->
	row Nos 12		row Nos 11		row Nos 10		row Nos 9		row Nos 8

9.2 Appendix 2

Producer Group Members

Name	Location
Janice & Ian Creed	Biloela
David & Bridget Corr	Biloela
Tom Carige	Biloela
Ann & Ron Carige	Munduberra
Col Burnett	Biloela
Wayne & Judy Moxham-Price	Biloela
Stuart Barrett	Biloela
Gavin & Megan Muller	Biloela, Ubobo
Scott & Judy Smith	Thangool

9.3 Appendix 3

Photo 1. Establishing leucaena at Drumburle

Photo 2. Established leucaena at Drumburle

Photo 3. Establishing leucaena at Lawgi Station Site 1

Photo 4. Failed establishment at Lawgi Station Site 2

Photo 5. Established leucaena at Lawgi Station Site 1

Photo 6. Sprayed grass strips in grass removal trial area Lawgi Station Site 1