Laggan Grazing Demonstration

2015 Results

Conducted at Shannon Arnall's, "Carinya", Laggan

Beginning January 2015

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Background

This on-farm demonstration began following the 2011 Crookwell Flock Ewe competition. Shannon Arnall had recently purchased a new block of 'native' country and was keen to increase profitability in the most cost-effective way. After several discussions with Phil Graham (NSW DPI) it was decided that a simple nutrient removal trial would be a good way to get a better handle on which nutrients are limiting pasture growth at 'Carinya', Laggan.

Part A: Nutrient Removal Trial

A nutrient removal trial is a simple way to identify which nutrients are limiting growth. This works by applying all nutrients to a measured area/plot ('All Nutrient') and then systematically removing a single nutrient from subsequent plots and comparing pasture growth. For example, the '**- P**' plot is all nutrients excluding phosphorous (Figure 1). The nutrient trial commenced in July 2013 on a native perennial based pasture containing some legume.

Figure 1: Nutrient removal trial layout at Carinya, Laggan*

*The only nutrient that cannot easily be 'removed' is sulphur. This is because most of the nutrients are applied in a sulphur form (e.g. magnesium is applied as Magnesium Sulphate). The '- Micro' treatment consisted of All Nutrients minus the micronutrients Copper, Zinc, Molybdenum and Boron.

Nutrient removal trial – timeline of events

4 July 2013

- Rep 1 and Rep 2 established and nutrients applied

17 April 2014

- Top up nutrients applied to Rep 1 and 2
- Shannon was also interested in a range of other products. The 'extra' treatments were also applied on 17 April

2 April 2015

- Top up nutrients applied to all treatments (except 125kg Mo Super on the lime treatments and the BioAg treatment– see below)

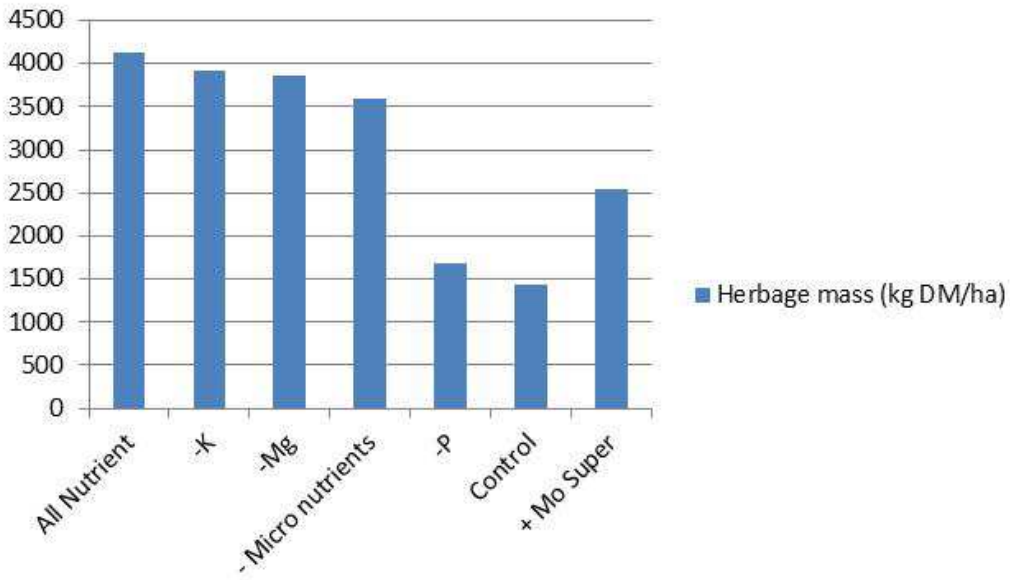
14 April 2015

- It was decided that half of the 3 x lime treatments should receive 125kg/ha of Mo single super. This was done on 14 April 2015.
- 125kg/ha of BioAg Superb treatments was also applied on the 14 April.

2015 Results

Herbage mass (kg DM/ha) was measured using a pasture probe (GrassMaster II) on 18 November 2015. Results for the two replicate plots were averaged and are presented in Figure 2.

Figure 2: 2015 results from the nutrient removal trial at 'Carinya', Laggan.



Part B: Grazing Demonstration

The nutrient trial showed that phosphorous (P) is the major nutrient limiting pasture growth (Figure 2). However, the question then became: ***what level of production can be achieved under commercial grazing conditions, and does it pay to put fertiliser out in a wool operation?***

To answer this question, an area near the nutrient trial consisting of similar pasture was fenced to create three 7 hectare paddocks. The selected treatments were:

Paddock 1: Single superphosphate + lime – fertiliser applied annually to increase soil P to a targeted level and agricultural lime (calcium carbonate) applied as a one off application to the native pasture to reduce soil acidity (pH).

Paddock 2: Control (no fertiliser or lime): a native pasture of low soil fertility.

Paddock 3: Single superphosphate: fertiliser applied annually to the native pasture to increase soil P to a targeted level.

Single superphosphate was selected as it is one of the most cost-effective ways of applying phosphorous to a grazing system. This has been proven in a long-term fertiliser trial at Bookham (Native Pasture & Alternative Fertiliser Project, Binalong/Bookham 2009 – 2014, unpublished data). Superphosphate also provides adequate amounts of sulphur – another key nutrient that is often deficient in tableland soils. Lime was also chosen to be applied across one of the treatments to investigate its economic viability in a native pasture based grazing system.

Prior to the paddocks being used for the demonstration they had not received super for at least 13 years. The paddocks consist of dense native based pastures containing the species Weeping grass (Microleana stipoides), Wallaby grass (Austrodanthonia spp.), annual grasses and subterranean clover (see Appendix 1). The soil is regarded as acid with a pH of 4.0 – 4.1 and approximately 40% aluminium (Al) to a depth of 10 cm. Soil testing to a depth of 20 cm has shown Al % to increase to between 50 to 66%.

What information is being collected?

Pasture growth rates: pasture growth rates (kg DM/ha) are being collected on a monthly basis using a pasture probe (GrassMaster II). This information is available on the South East LLS website. Pasture growth rate data is useful to help determine viable stocking rates at various times of the year.

Soil nutrient levels, pH and soil carbon: baseline soil testing occurred prior to any treatments being applied. This data is summarised in the Table 1 below. Soil tests are taken annually in late spring to a depth of 10 cm to monitor changes over time. Refer to Appendix 2 for the latest soil test results.

Table 1: Baseline soil test results for the three treatments

	pH	Aluminium	Phos Buffering Index	Phos (Colwell)	Sulphur	Potassium
	(CaCl)	%	L/kg	mg/kg	mg/kg	cmol (+)/kg
Super + lime	4.1	38	120	11	5.4	0.64
Control	4.0	38	120	9.4	4.8	0.63
Super	4.0	45	110	8.8	3.7	0.40

Lime movement over time: the movement of surface applied lime down through the soil profile will be measured annually to a depth of 20 cm. Complete soil cores were taken in December 2014 down to a depth of 20 cm and cut into four 2.5 cm segments down to a 10 cm depth and then cut into two 5 cm segments down to 20 cm. The same sampling protocol is used annually to monitor changes in pH and Al%. Following the baseline readings lime movement will now always be monitored in autumn to ensure a better chance of receiving enough moisture at depth in order to take soil cores. Refer to Appendix 3 for results collected to date.

Animal data: wethers were initially weighed on 14 January 2015, and then again on 3 June 2015 (Table 2). Wethers will continue to be weighed regularly so that similar body weights are maintained across the treatments. If body weight is kept the same then wool characteristics will be similar allowing a fair economic assessment of treatments.

Table 2. Average wether liveweight (January and June 2015)

Pdk No.	Treatment	LW on 14.1.15 (ave)	LW on 3.6.15 (ave)	Difference (kg LW)
1	Super + lime	45.8kg	45.5	-0.3
2	control	44.8 kg	44.8	0
3	super	44.8 kg	44.1	+0.7

Wool data (fleece weight, fibre diameter, strength etc.) will be collected to enable economic comparisons to be made across treatments.

Pasture composition: a botanical analysis will be conducted on an annual basis using the 'End Point Evaluation' technique. This assessment will detect any changes in pasture composition across the treatments (see Appendix 1). Ground cover at various times of the year will also be assessed.

2015 Results

- Merino wethers were shorn in December 2014 and allocated to all three treatments on 14 January 2015. The control paddock was allocated 35 wethers (5 wethers/ha) and the two treatment paddocks received 45 wethers (6.4 wethers/ha).
- **Lime** was applied to the surface on 9 January 2015 at a rate of **2.5t/ha**. **Single superphosphate (containing 0.025% Molybdenum)** was applied to the fertilised treatments on 1 February 2015 at a rate of **125kg/ha.**
- Significant rainfall in January (Crookwell recorded 138mm for the month) resulted in wethers grazing around 1000kg of DM/ha (green) at the start of the demonstration. However, dry conditions in February and March meant that pastures dried out quickly and the amount of green leaf started to disappear (Figure 3). Herbage mass (green) at the end of March was down to around 500kg DM/ha (Figure 4).
- Excellent rainfall in April boosted pasture growth, but May growth rates were very low. There is no doubt that temperature would have started to become a limiting factor, but perhaps we were seeing some effects of nitrogen deficiency as a result of the previous summer rainfall?

- Wethers were drenched on 12 May and removed from all treatments. This was done in order to try and increase available pasture before winter. Wethers were placed back on the treatments on 3 June. The total rest time for the pasture was 23 days.
- Winter 2015 was particularly tough with the district receiving in excess of **30cm of snow** in mid July. The negative pasture growth rates associated with July are a result of frost burning the leaves and shifting green material into the 'dead' pool (Table 3).

Figure 3: Crookwell rainfall -2015

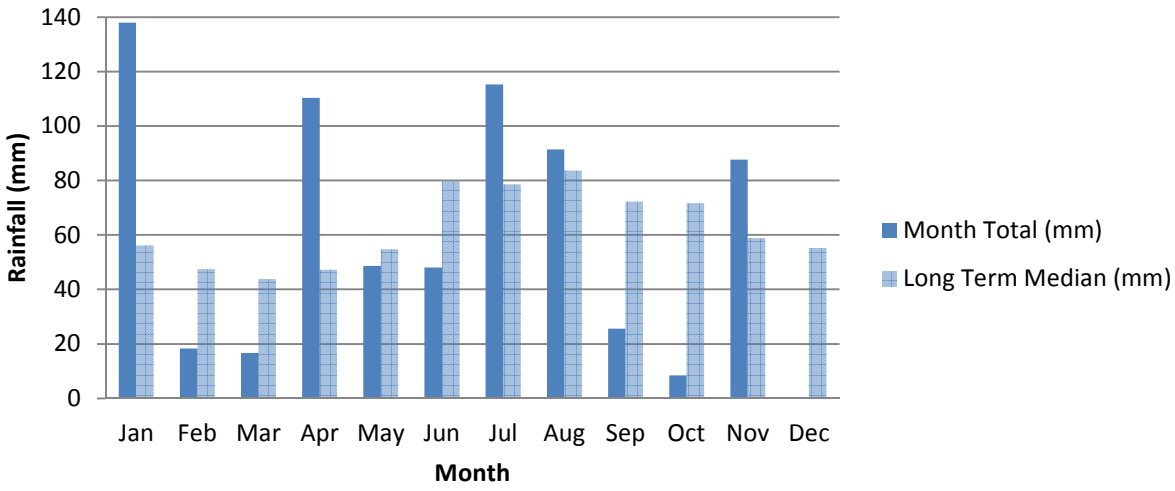
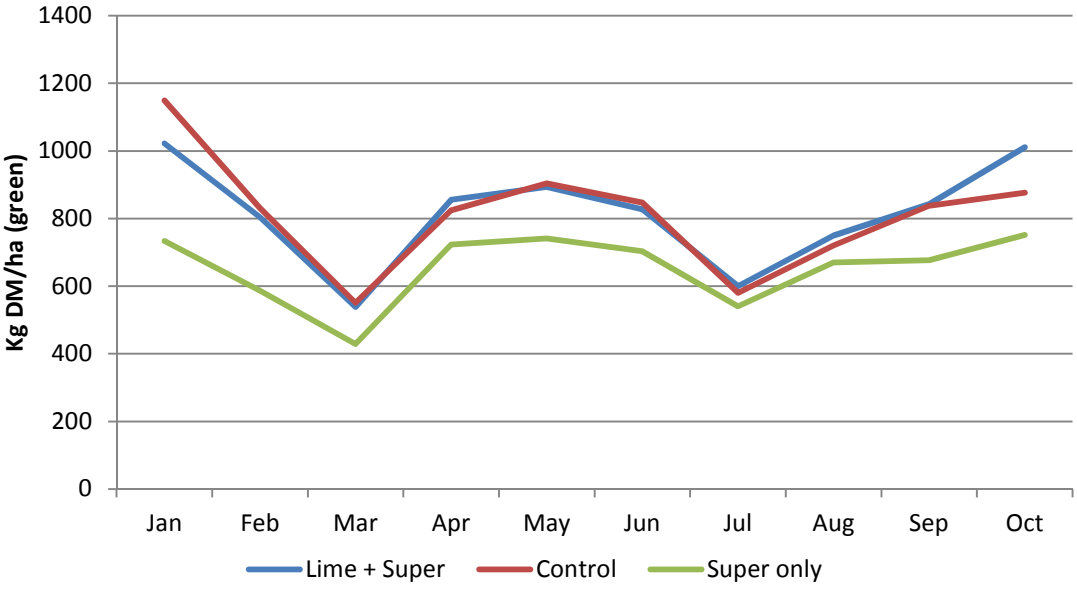


Figure 4: End of month herbage mass – green component (kg/DM/ha)



- Although there was good soil moisture at the end of winter, lack of rainfall in September and October meant that the top soil dried out, restricting pasture growth. This is reflected in very modest pasture growth rates for these months (Table 3).
- Treatments were assessed for bracken fern as it appeared that Paddock 3 (super only treatment) had more bracken fern, and therefore less effective area for sheep to graze. A handheld GPS unit was used to map out the amount of bracken fern in all treatments. Each patch of bracken fern was assessed in terms of its impact on grazing (Table 4).

- Calculations showed that the super only treatment had almost 2 ha completely removed from the system due to bracken fern. This was much more than the other two treatments. Table 3 shows the adjusted stocking rate once the bracken fern is taken into account. With control measures being undertaken on the bracken fern it is expected that its impact will diminish over the next 12-18 months so that all treatments even out in terms of effective grazing area.
- Wethers from all three treatments were shorn on 10 December 2015. Individual fleeces were weighed and tested for micron, staple length, staple strength etc. This information was then used to calculate a full economic comparison for the first 12 month period (Table 5).

Key points:

- The application of P at the beginning of February 2015 had an immediate impact in the first year. The two fertilised paddocks responded, growing more pasture and were able to sustain higher stocking rates (+ 28%) than the control.
- Higher stocking rates meant the fertilised paddocks cut more clean wool per hectare:
  - control: 17.5kg clean wool/ha;
  - super: 26.7kg clean wool/ha;
  - super + lime: 23.9kg clean wool/ha
- When all the costs are taken into account (i.e. the costs of fertiliser as well as extra variable costs of running more stock), the super only treatment generated a **net profit of $27/ha**. This extra income has been achieved in the first year of application in an 'average' year. It is expected that the returns from applying superphosphate will increase in the coming years as a result of:
  - Slightly lower fertiliser cost/ha. Molybdenum (Mo) super was applied in the first year however Mo won't be needed for at least 5 years, thereby reducing the cost of fertiliser by around $5/ha.
  - Gradual increase in stocking rate as a result of additional soil fertility, including higher soil nitrogen levels from increased sub clover growth.
- The additional cost of lime combined with a lower stocking rate (compared to the super only treatment) meant that the super + lime treatment didn't reach a break-even point in the first year.

The Bookham grazing demonstration:

- A similar study was conducted over a 13 year period at 'Kia-Ora', Bookham, NSW. The Bookham Grazing Demonstration (520m elevation) showed that applying single superphosphate resulted in a 2-fold increase in stocking rate, generating an additional $79/ha in profit (Appendix 4).
- It will be interesting to see if a similar increase in stocking rate can be achieved at the Laggan site at 1000m elevation.

Table 3: Pasture Growth Rates –' Carinya', Laggan and 'Kia-Ora', Bookham. Pasture Growth measured in kg DM/ha/day

		J	F	M	A	M	J	J	A	S	O	N	D
Carinya, Laggan (1000m)													
Super + lime		nc	2	-1	19	3	5	-2	11	11	16		
Control		nc	-3	-3	15	4	4	-4	9	10	8		
Super		nc	5	4	19	2	7	2	11	10	13		
Kia-Ora, Bookham (520m)													
2015	**Super**	green	green	green	25	16	7	8	17	31	58		
2006	**Super**			nc	nc	nc	15	15	15	nc	nc	nc	
	No Super			nc	nc	nc	7	7	8	nc	nc	nc	
2005	**Super**			nc	5	0	14	15	19	26	45/70		
	No Super			nc	3	0	7	8	8	12	32		
2004	**Super**	nc		nc	0	0	15	15	19	26	84	77	nc
	No Super	nc		nc	0	0	7	6	7	13	33	35	nc

nc = not collected

Table 4: The amount of grazing area affected by bracken in each treatment and the adjusted stocking rate

Treatment	Pdk size (ha)	Area affected by bracken (ha)	Adjusted area (ha)	Original stocking rate (wethers/ha)	Adjusted stocking rate (wethers/ha)
Paddock 1 (Super + lime)	7.02	0.82	6.20	6.4	**7.3**
Paddock 2 (control)	6.98	0.66	6.32	5.0	**5.5**
Paddock 3 (super)	6.97	1.84	5.13	6.4	**8.8**

Table 5: Grazing demonstration – economic assessment for period Jan 2015 – Jan 2016

INCOME				
		Control	**Super**	**Super + lime**
Production				
Area of paddock*	ha	6.32	5.13	6.2
Number of wethers	per paddock	35	45	45
Stocking rate	per ha	5.5	8.8	7.3
GFW (kg)	per head	4.5	4.4	4.7
Clean wool (kg)	per head	3.16	3.05	3.30
Micron	average	18.4	17.6	18.0
Production				
Clean Wool (kg)	per ha	17.49	26.73	23.98
Wool Price (Dec 2015)	cents/kg clean	1470	1514	1500
WOOL INCOME ($/HA)		257.09	404.71	359.71
COSTS				
Variable Costs	$/ha			
Animal health ($2.00/hd)		11.08	17.54	14.52
Wool harvesting and selling costs ($12/hd)		66.46	105.26	87.10
Fertiliser costs		0	60	85**
Feeding costs		0	0	0
TOTAL VARIABLE COSTS		77.53	182.81	186.61
Interest on stock (6% interest @ $80/hd)		NA	15.52	8.26
TOTAL COSTS		77.53	198.33	194.87
PROFIT				
$/ha		**179.56**	**206.38**	**164.84**
Difference (to control)			26.82	-14.72

* Paddock areas were adjusted to take into account grazing area lost to Bracken fern (i.e. some paddocks had more bracken fern than others. A handheld GPS unit was to map out the amount of bracken fern in all treatments.

** The cost of applying lime ($25/ha) is presented as an annualised cost. This cost is based on lime delivered at 'Carinya' plus spreading costs and interest (6% p.a.) over a 10 year period (all prices GST exclusive). The annualised cost of lime ($25/ha) is then added to the cost of single superphosphate ($60/ha), bringing the total to $85/ha.

Appendix 1: Botanical Compostion

Botanical composition was assessed on 9 October 2015 using the 'End Point Evaluation' technique (refer to Table 6 for results to date). This measurement will be repeated annually in Spring to see if botanical composition changes over time. In other words, is there an increase, decrease or no change of certain species as a result of treatment and/or management?

Table 6: Botanical compostion of the three treatments at 'Carinya'. Numbers indicate the percentage of species present in the pasture sward.

Species	Pdk 1: Super + Lime			Pdk 2: Control			Pdk 3: Super only		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
Microlaena	40			52			43		
Danthonia	22			25			23		
Yorkshire Fog	1			0.5			0		
Annual Grasses	6			0.5			5		
Legumes	19			8			13		
Weeds	5			2			1		
Bare ground	1			2			2		
Litter	5			10			13		
Other	1								

Appendix 2: 0-10cm soil test results (summary)

Treatment	pH (CaCl)	Al %	PBI L/kg	Colwell P mg/kg	Sulfur mg/kg	Potassium cmol(+)/kg	Cation Exch Capacity cmol (+)/kg
Sample date: 10 Dec 2014 (Baseline)							
Paddock 1 (Super + Lime)	4.1	38	120	11.0	5.4	0.64	4.7
Paddock 2 Control)	4.0	38	120	9.4	4.8	0.63	4.5
Paddock 3 (Super)	4.0	45	110	8.8	3.7	0.40	4.0
Sample date: 26 Nov 2015							
Paddock 1 (Super + Lime)	4.2	17	120	11.0	4.3	0.47	5.7
Paddock 2 Control)	3.8	38	120	9.9	4.6	0.68	5.0
Paddock 3 (Super)	3.8	46	110	9.4	4.9	0.36	4.4

Appendix 3: Lime movement results (2014 -)

pH(CaCl2) Profiles

PADDOCK 1 - Lime @ 2.5 t/ha once + Super @ 125 kg/ha/yr							
2014	2015	2016	2017	2018	2019	2020	Depth (cm)
4.2							2.5
4.1							5
4.0							7.5
4.0							10
4.0							15
4.1							20

PADDOCK 2 - Nil Fertilizer & Nil Lime							
2014	2015	2016	2017	2018	2019	2020	Depth (cm)
4.3							2.5
4.0							5
4.0							7.5
4.0							10
4.1							15
4.1							20

PADDOCK 3 - Super @ 125 kg/ha/yr							
2014	2015	2016	2017	2018	2019	2020	Depth (cm)
4.2							2.5
4.0							5
4.0							7.5
4.0							10
4.1							15
4.1							20

Aluminium (% of CEC)

PADDOCK 1 - Lime @ 2.5 t/ha once + Super @ 125 kg/ha/yr							
2014	2015	2016	2017	2018	2019	2020	Depth (cm)
16.0							2.5
34.0							5
42.0							7.5
50.0							10
52.0							15
55.0							20

PADDOCK 2 - Nil Fertilizer & Nil Lime							
2014	2015	2016	2017	2018	2019	2020	Depth (cm)
12.0							2.5
35.0							5
42.0							7.5
46.0							10
52.0							15
57.0							20

PADDOCK 3 - Super @ 125 kg/ha/yr							
2014	2015	2016	2017	2018	2019	2020	Depth (cm)
16.0							2.5
41.0							5
48.0							7.5
52.0							10
62.0							15
66.0							20

Key: **Limed Paddocks**

"Lime Effect" >0.3 unit change

Reduced Al% to < 5%

Possible "Lime Effect"
(>50% change since initial 1998 Al% reading)

Appendix 4: Results from the Bookham Grazing Demonstration

13 Year wether production data from the Grazing Demonstration at 'Kia-Ora', Bookham NSW.

SUPER	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	13 YEAR AVGE
Stocking Rate / ha	11.05	10.70	11.20	12.80	13.20	14.00	14.90	14.90	14.60	12.60	14.50	15.10	15.10	13.43
Total Clean Wool kg/ha	35.30	39.90	41.30	39.90	43.60	50.20	53.60	56.00	43.50	31.60	34.00	41.50	35.40	41.98
Total Wool Income $/ha	462.43	251.37	255.73	374.66	218.44	347.43	701.41	574.56	581.16	285.35	311.58	341.13	415.95	393.93
Total Cost $/ha	258.32	225.97	217.28	248.73	251.09	228.96	281.51	297.64	289.89	392.99	344.11	333.48	321.06	283.92
Profit $/ha	204.11	25.40	38.45	125.93	-7.33	136.01	419.90	276.92	291.27	-107.64	-32.53	7.65	94.89	113.31
Difference Super-No Super $/ha Profit	94.90	5.07	23.86	72.04	15.24	124.31	287.63	209.04	123.67	-41.65	-9.65	40.67	78.82	**78.76**
Cost of Production c/kg Clean	7.32	5.66	5.26	6.23	5.76	4.56	5.25	5.32	6.66	12.44	10.12	8.03	9.07	7.05
NO SUPER	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**13 YEAR AVGE**
Stocking Rate / ha	6.30	6.30	6.30	6.30	6.30	6.30	6.10	6.10	6.30	6.10	5.80	5.30	5.80	6.10
Total Clean Wool kg/ha	19.50	22.90	22.20	19.50	19.50	23.80	22.90	22.50	22.10	15.60	15.60	15.50	14.10	19.67
Total Wool Income $/ha	253.50	151.83	138.46	191.30	116.22	149.94	288.08	225.00	333.05	158.50	151.32	122.76	178.08	189.08
Total Cost $/ha	144.29	131.50	123.87	137.41	138.79	138.24	155.81	157.12	165.45	224.49	174.20	155.78	162.01	154.53
Profit $/ha	109.21	20.33	14.59	53.89	-22.57	11.70	132.27	67.88	167.60	-65.99	-22.88	-33.02	16.07	34.54
Cost of Production c/kg Clean	7.40	5.74	5.58	7.05	7.12	5.81	6.80	6.98	7.49	14.39	11.16	10.05	11.49	8.23