

Managing staple length in fine-wool sheep using shearing interval

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Abstract. Anecdotal evidence, confirmed by an analysis of six years wool sales data, indicates that selection to reduce fibre diameter and maintain, or increase, fleece weight, has led to an increase in the quantity and staple strength of fleeces produced. Long staples attract a price penalty. However, a comparison of 9- *vs.* 12-monthly shearing indicated that reducing the shearing interval to 9 months did not lead to any significant improvement in gross margins. An analysis of the effects of age and growth period on the repeatability of staple length indicated that sheep with the potential for long staple lengths could be allocated to appropriate management groups at 9 or 12 months-of-age.

Keywords: staple length, shearing interval, fine-wool.

Introduction

Wool processors discount fine long staple length wool because it is not consistent with their machinery settings, which leads to a higher number of woven fibre breakages. In the last 10-20 years, many commercial woolgrowers moved to reduce the fibre diameter of their wool clip and benefit from the then higher premiums being paid for lower fibre diameter wools. Selection has aimed to reduce fibre diameter while maintaining, or increasing, clean fleece weight. However, these aims can only be achieved by increasing staple length and/or the number of fibres.

Anecdotal evidence indicates many of these clips are discounted (160-180 cent/kg for 100mm vs 80mm staple length wool of 18 microns in 2001/2; AWEX Market Reports) due to their long staple. Traditionally, fine wool flocks have had a staple length of 70 - 80mm in fleeces grown over 12 months. However, genetically selected flocks in different environments are producing fine wool in the 90 to 100mm range at hogget and 2-year-old shearings (12 month growth). For example, the Trangie QPLU$ selection lines have also shown increased staple length of medium wools selected for reduced fibre diameter compared with traditional fine wool sheep (Taylor et. al. 2000). Similarly, reports in traditional fine wool production areas suggest concern over long staples for superfine wools (J. Maclaren, 2002, *pers. comm.*).

The problem is most pronounced in young sheep, as they produce finer fleeces than adults and length penalties are greater for lower fibre diameter fleeces. A shorter shearing interval is one means of reducing staple length of the fleece, although moving away from 12-monthly shearings adds to the complexity of the management calendar.

This paper seeks to verify anecdotal evidence of the trend for increases in the quantity of fine wool produced and an increased proportion of that wool to be over-length in an analysis of sales data for the period 1997-2003. Further, some of the consequences of reducing the shearing interval are evaluated with both experimental and desktop approaches.

National staple length and fibre diameter profile

Data was obtained from the AWEX database for lots of Australian Superfine and Merino fleece wools (from adult sheep) sold in selling seasons 1997/1998 to 2002/2003. Lots were grouped by fibre diameter ranges within AWEX length categories (Australian Wool Exchange 2001), based on the AWEX-ID or the measured staple length, if reported. AWI *Pricemaker* data from the last three full selling seasons indicate that discounts of 17-18.5µm for long staples commenced above 85mm. For this reason, this study reports the incidence of wools in length categories 90 (86-95) mm and longer.

Annual variation in wool quantity

Seasonal conditions have an impact on the total national fleece production. This was particularly evident in 2002/3 where the effects of drought and low sheep numbers resulted in a decline of 35% in the total quantity of fleece wool sold.

Fine-wool fleeces sold climbed from 35,963 t in 1997/8 to 63,168 t in 2001/2, increasing as a percentage of the national total from 12.35% to 18.57% over the same period. The effects of drought and low stock numbers on the quantity of fine-wool sold was considerably less with a reduction in 2002/3 of only 7.7% on the quantity sold in 2001/2. Hence, the fine-wool percentage of the national total jumped to 26.53%.

The quantity of fine wool sold over the 6-year period increased in all states.

Annual variation in staple length x fibre diameter profile

With increases in the quantity of fine-wool produced and sold, the quantity of these wools in length categories of 90mm and longer also increased, with 70.6% more nationally in 2002/3 than in 1997/8. On a national basis, these longer categories represented between 30 and 40% of the fine-wool fleeces sold over the 1997/8 to 2002/3 seasons.

Our conservative estimates of the value of discounts nationally within fine (<19.5µm) adult fleece wools over the last 5 years are:

Year	$
98/99	5,168,524
99/00	6,102,885
00/01	13,607,825
01/02	10,979,318
02/03	8,876,969
Total	44,735,522

These figures are calculated using historical information of percentage premiums and discounts (Kerrie Stott, Woolmark Business Intelligence, 2004, pers. comm.) and the annual average weekly market indicators per fibre diameter category (S. Semple, 2004, *pers. comm.*). Where data were not available for length categories within the ≤ 16.0 and 16.1-17.4 µm ranges, the discount applied was that for the respective length category within the 17.5-18.5 µm range, and as no market indicator for diameters ≤ 16.0µm was available, the 16.1-17.4 µm indicator was applied. (Hence, the calculated discounts will be underestimates.)

The decline in the estimated value of discounts in 2001/2 and 2002/3 reflects a decline in price, and a small decline in the percentage discount in 2002/3.

Comparison of 9- vs. 12-monthly shearing

The sales survey data supported anecdotal evidence of a quantitative increase in the production of fine wool with longer staples over the six years studied. The estimated cost to industry was substantial. Because the length penalties are greater for finer fleeces, the penalties will be greatest in younger sheep. A reduction in the fleece growth period will reduce staple length. An experimental approach compared production and financial outputs of 9- and 12-monthly shearings in two fine wool flocks that had previously reported problems with length penalties. A shearing interval of nine months was selected for young animals, as 3-year-old animals would then fall back in synch with the annual 12-monthly shearing of older adults.

Methods and materials

Commercial assessment of the quantity and quality of fleeces shorn at 9- and 12-monthly intervals from young sheep was conducted on two Tablelands properties, in Southern and Central NSW. The assessment continued for three years.

In spring 2002, 100 Merino wether weaners were selected from each fine wool flock and randomised into two groups, fifty to be shorn at 9-monthly intervals for three years and fifty shorn at 12-monthly intervals.

Liveweight and condition score were recorded at 3-monthly intervals at which time a record of pasture availability was also obtained.

At shearing, a midside sample was collected before fleeces were weighed, skirted, re-weighed and individually stored for later commercial appraisal and valuation.

The midside samples were sent to the Australian Wool Testing Authority (AWTA) laboratory at Yennora for determination of mean fibre diameter, yield, staple strength and staple length of each fleece. The position of break for each fleece was calculated from ATLAS (Thompson et al. 1988) individual staple data. In addition, an estimate of the vegetable matter was obtained from a guidance test on a sample obtained by pooling sub-samples from the available midside samples.

At a central point, the fleeces were displayed individually and AWTA test data for each fleece made available to a commercial wool valuer to allocate a style, value and an AWEX-ID.

Using objective information from the AWTA tests, and the style and AWEX-ID, values were estimated for each fleece using historical prices through the WoolCheque website (www.woolcheque.com.au). Price data for four seasons (2001/2, 2002/3, 2003/4 and 2004/5) were used to provide four further valuations of each fleece. Gross margins for each animal over the 3-year period were calculated by summing the values of the fleeces produced and subtracting a shearing cost for each fleece ($5/shearing).

Each of the five gross margins was analysed using ASReml (Gilmour et al. 2004) to examine the effects of site and shearing interval and their interaction.

Results and Discussion

<u>Rainfall</u> Drought was prevalent for much of the project's duration but was more severe at the Southern site (Murringo) than at the Central site (Orange). Between July 2002 and July 2005 (representing the period from birth to final shearing at 36 months at the Central site) the recorded rainfall, expressed as a proportion of the monthly mean, averaged 0.72 at Murringo, twice the deviation from the mean recorded at Orange (0.86).

<u>Pasture availability</u> Pasture availability reflected the rainfall patterns experienced over the duration of the project. At the Central site, the availability of green herbage only exceeded 1000 kg DM/ha on three of the twelve assessments, in the spring (October) in each year, although total DM availability exceeded that level on the majority of assessments

At the Southern site, the availability of green herbage exceeded 1000 kg DM/ha on one occasion only in November 2004, when approximately 3.6 t total DM/ha was present mainly as green material. On only one other occasion did the availability of total DM approach 1000 kg DM/ha, and that was in November 2003.

<u>*Fleece metrology*</u>

Drought undoubtedly had an influence on fleece metrology at both sites by reducing fibre diameter, clean weight, and staple length in particular. The more severe drought conditions on the Southern Tablelands would have contributed to the low yields

Staple length was highest in the flock at the Central site. With 12-monthly shearings, over-length was penalised in the majority of fleeces and more particularly at younger ages. Reducing the interval to 9 months minimised length penalties at 9-months of age, both long (18 months) and short (27 and 6 months) staples proved a problem at later shearings.

Short staple penalties were high (>85%) with a 9-monthly shearing at 18- to 36-months of age. However, increasing the shearing interval to 12 months was associated with both short (24+% at 24 and 36 months) and long (47% at 6 months) penalties, indicating the variability in staple length within this flock. Shearing interval did not affect the yield or style.

<u>*Gross margins*</u>

Increasing the frequency of shearing is associated with a proportionate increase in costs. After deducting shearing costs of $5/head per shearing, there was no advantage (P>0.05) in gross margins/head by reducing the shearing interval (9-monthly shearing) under any of the price scenarios tested However, length penalties (short staples) for 9-month fleeces resulted in significantly lower gross margins at the Southern site under 3 of the price scenarios (2004, 2005 and the commercial valuer).

Seasonal wool growth

Variation in staple length within both shearing intervals (within and between ages) was evident. To eliminate length penalties completely would require differential management of the flock, to identify groups requiring more frequent shearing or even manage individuals such that they were shorn when their staple length fell within an optimum range. The former approach would require that staple length was repeatable and the optimum age to identify those management groups. The latter approach is likely to require high labour inputs. A second study within the same two flocks examined the repeatability of staple length grown over a number of different periods and ages. Information on wool growth at different ages was also used in a simulation study to examine the impact of shearing to optimise staple length of individual animals.

Methods and materials

The impact of wool growth within different time spans on the quantity and quality of wool was examined more intensively on additional animals at each of the sites.

A further twenty weaners were selected at each site in spring 2002 for intensive measurements. Each of the twenty intensively measured sheep had four mid-side patches clipped at 3, 6, 9 and 12 monthly intervals. A 5th patch was initially clipped at 3 months of age, and then at 9-monthly intervals (simulating a lamb-tipping shearing with subsequent 9-monthly shearing). The position of each of the clipping interval treatments was randomly allocated between the five adjacent positions on the midside. The remainder of the fleece from these animals was shorn at 12-monthly intervals.

The clipped patch size was determined using a photographic technique (Lee et al. 2004). The mid-side patch wool samples were weighed greasy before and after staples were randomly chosen for measurement of staple length and the fibre diameter profile using OFDA2000 (Baxter 2001). The remainder of each sample was aqueous scoured, allowing calculation of clean wool growth/unit area.

Repeatability of staple length The repeatability (Turner and Young 1969) of staple length across different growth periods and ages was estimated from the within and between animal variances estimated from bivariate analyses using ASReml (Gilmour et al. 2004). The model fitted site, age (linear) and clipping frequency, together with their interactions, as fixed effects and animal, patch position and age (as a factor and as a spline) together with interactions as random effects. Non-significant terms were sequentially deleted.

Simulations of management to optimise staple length Using the daily length growth from patches clipped at 3-month intervals, a desk top study was conducted to simulate shearing times that optimised staple length (80-90 mm or 75-85 mm for the Central and Southern sites, respectively), from birth to 36 months of age. Staple length was calculated from the rates of daily length growth for each appropriate period. Shearing was determined to be when the longest fleece reached the top of the 'optimum' range, when all sheep with fleeces within that range were "shorn".

Results and Discussion

Repeatability of staple length **Table 5** indicates the estimated repeatability of staple strength measured at different ages in the first 12 months and staple length at later ages (with varying growth periods).

As expected, the repeatability tends to decline as the interval between the two measures increases. Staple length measured at 3 or 6 months of age was poorly related to staple length at ages older than 18 months.

The repeatability of estimates taken at 9 or 12 months of age of staple length, grown over 9 or 12 months, with staple lengths up to 36 months of age indicated that 9 or 12-months would be an optimum time to class weaner sheep on staple length potential.

Simulations of management to optimise staple length Over the 3-year period, shearing to keep staple length within the specified ranges required at total of 17 and 11 shearing dates at the Central and Southern sites.

Most (16 of 20) sheep in the Central group were each shorn on 4 occasions, and the remainder 3 times, while at the Southern site, all sheep were shorn on three occasions. At each site, four groups of animals (representing 65 and 85% of the animals at the Central and Southern sites, respectively, or 11 and 9 of the shearings at the respective sites) had common shearing dates throughout the three year study. This supports the concept that staple length is a repeatable trait and that management groups based on staple length could be identified at an early age (we would suggest 9- or 12-months of age.

Management Implications

More frequent shearings (eg 9-monthly) would add a further layer of complexity to management planning of the operations calendar. A system that includes shearing a number of age groups at 9-monthly intervals would require four shearings per year.

Although 9-monthly shearings can reduce staple length in flocks with high staple length growth rates, under the five price scenarios tested, there was no advantage in gross margin. However, at lower rates of staple length growth (whether related to genetic potential or seasonal conditions) the results indicate 9-monthly shearing can significantly reduce gross margins under some price scenarios tested.

In addition, 9-monthly shearings in flocks with high length growth rates did not eliminate over-length penalties. Hence, the simulation study examined the consequences, in terms of complexity of management, of managing to shear individuals when staple length was within the optimal range. Managing one age cohort alone required 17 shearings over the three year period, which clearly would be of little practical interest.

Normal management usually requires sheep to come into the shed twice annually (crutching and shearing). An alternative to manage the animals with higher length-growth rates might be to shear at 6-monthly intervals. This would also only require two shearings annually, limiting cost increases associated with the second shearing while replacing a crutching procedure. However, further simulations using the patch data indicated only a small proportion of the sheep from the high length-growth rate flock would have staples over 70mm, and only then up until 15 months of age.

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Appendix

Table 1 Total fine-wools (≤19.5 microns) sold and fine-wool sold within AWEX length categories of 90mm or greater by State of production and year.

	97/98	98/99	99/00	00/01	01/02	02/03
All fine-wool fleeces (t)						
NSW	19,713	19,946	17,538	17,626	30,382	26,756
Qld	854	786	1,164	1,432	4,756	4,586
SA	399	490	846	505	1,106	1,771
Tas	1,663	2,247	1,603	2,726	3,122	2,817
Vic	10,420	9,383	9,961	11,348	13,586	15,073
WA	2,913	4,137	6,149	7,722	10,215	7,314
National Total	35,963	36,990	37,261	41,359	63,168	58,318
Fine-wool fleeces ≥ 90 mm (t)						
NSW	4132	5574	4753	5178	9507	7127
Qld	202	234	241	343	1103	595
SA	187	230	409	255	519	825
Tas	629	1760	635	716	1442	971
Vic	4514	4873	4907	6243	7037	6062
WA	1214	1924	2734	2693	3587	2974
National	10,879	14,597	13,682	15,432	23,200	18,560

Figure 1 Cumulative rainfall deficits at Murringo (Southern) and Orange (Central).

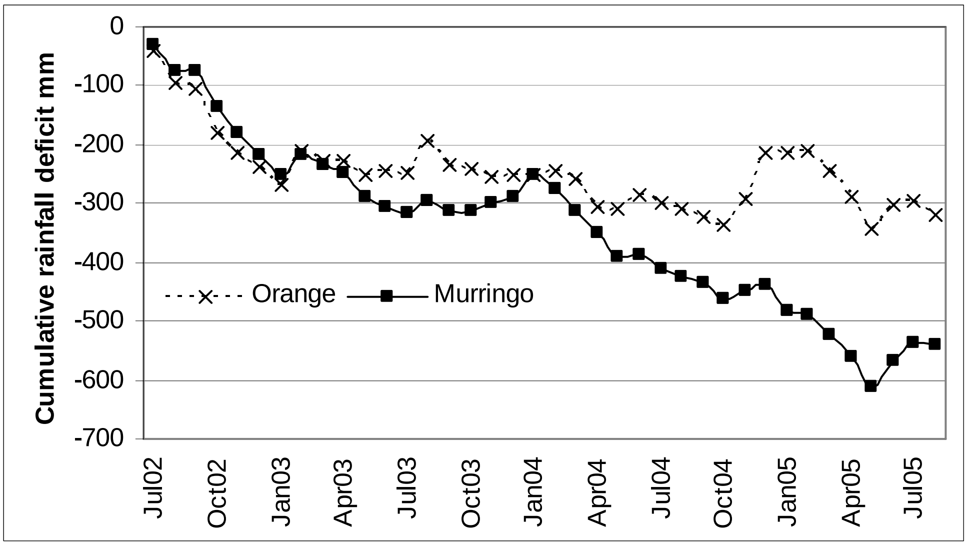

Figure 2 Pasture availability at the Central site over the period of the project

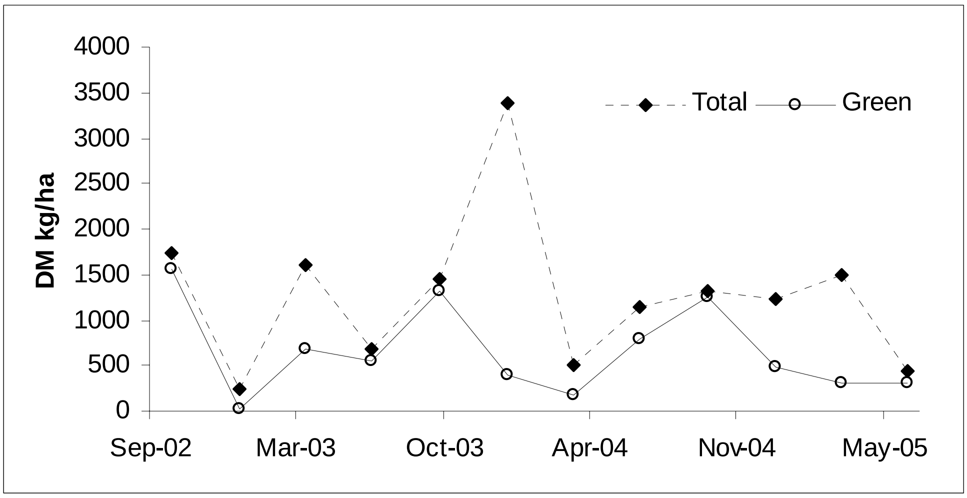

Figure 3 Pasture availability at the Southern site over the period of the project

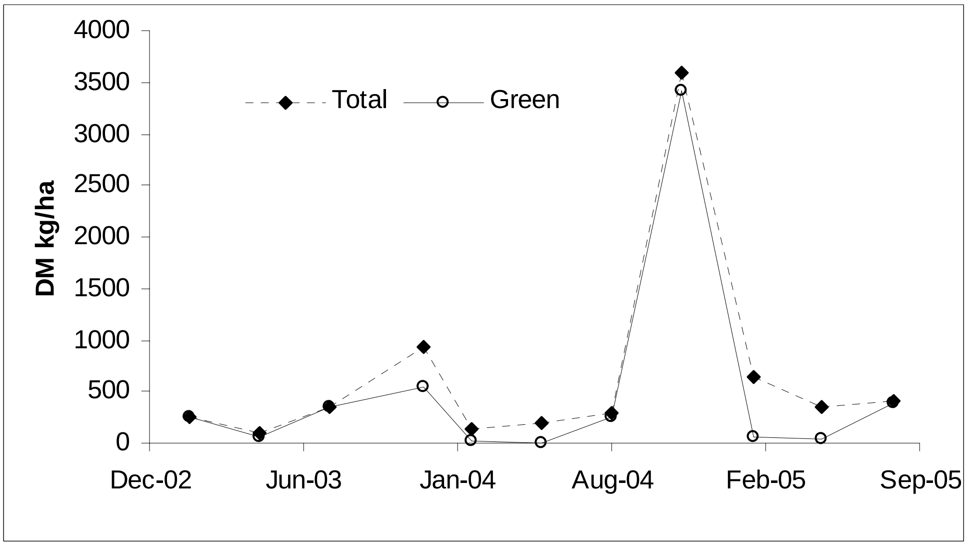

Table 2 Metrology of fleeces (mean and sd) from sheep shorn at 9- or 12-monthly intervals

		Treat:	9-monthy				12-monthly		
	Site	**Age mths:**	**9**	**18**	**27**	**36**	**12**	**24**	**36**
Clean Weight	Central		1.54	2.96	2.37	2.57	2.39	3.07	3.39
kg			0.23	0.36	0.31	0.40	0.30	0.41	0.57
	Southern		1.03	1.89	1.55	2.11	1.45	2.23	3.07
			0.21	0.28	0.32	0.26	0.16	0.32	0.51
Yield	Central		73.5	76.2	78.5	78.3	75.7	76.2	78.2
%			3.3	4.0	3.4	2.8	3.0	3.2	2.8
	Southern		60.4	62.3	70.3	62.1	61.4	58.7	62.0
			9.1	3.5	4.5	6.5	6.3	5.2	5.3
Fibre	Central		16.0	18.8	18.0	19.0	16.7	18.0	18.8
diameter			0.9	1.1	1.1	1.4	0.9	0.9	1.1
µm	Southern		16.0	18.1	16.6	17.5	15.8	16.9	17.8
			1.1	1.3	1.1	1.3	0.9	1.1	1.2
Staple length	Central		80.9	93.8	81.6	77.1	115.2	107.5	100.5
mm			8.3	7.6	9.2	6.7	9.3	9.7	9.9
	Southern		64.3	67.7	60.8	67.7	82.8	76.3	87.2
			7.6	6.5	5.1	6.3	11.2	9.7	10.9
Staple	Central		36.6	50.5	43.2	49.4	30.5	36.3	42.5
strength			9.8	7.7	7.0	9.7	7.6	9.5	8.3
N/ktex	Southern		33.5	41.4	35.7	36.2	29.9	24.2	34.3
			9.7	6.1	8.1	8.6	8.0	7.5	8.8
Hauteur	Central		59.7	74.5	67.2	68.3	76.3	72.3	77.4
mm			8.1	8.8	6.4	8.4	8.2	8.2	8.1
	Southern		45.1	56.3	50.1	48.2	51.6	54.4	64.5
			6.3	7.2	7.5	7.3	8.4	7.3	8
POB	Central		33.7	37.9	26.2	75.6	28.8	66.8	78.6
%			13.1	12.6	8.8	6.6	11.5	5.1	6.6
	Southern		59.3	37.7	34.8	57.5	46	80.1	71.2
			9.1	6.5	8.4	8	8.6	7.4	6.7
Style	Central		4.0	4.1	4.0	5.0	4.02	4.02	5.0
	Southern		5.02	5.0	5.0	5.02	5.0	5.0	5.1

Table 3 Commercial valuation of fleeces from sheep shorn at 9- and 12-monthly intervals and the percentage penalized for staple length, and the percentage under 80 mm and over 90 mm.

			Commercial Valuer					
Site	**Treatment**	**Age**	**Fleece Value**	**Short Penalties %**	**Long Length penalties %**	**<80mm %**	**>90mm %**	**No. of fleeces**
Central	9	9	2541	6.1	2.0	42.9	12.2	49
		18	2825	0.0	25.5	4.3	68.1	47
		27	2650	21.7	6.5	34.8	6.5	46
		36	2211	48.9	8.9	63.6	2.3	44
		Total	**10227**	**18.7**	**10.7**			**187**
	12	12	2799	0.0	83.7	0.0	100.0	49
		24	3364	0.0	93.0	0.0	95.3	43
		36	2910	2.4	64.3	8.3	70.8	48
		Total	**9074**	**0.7**	**80.6**			**134**
Southern	9	9	1189	17.0	0.0	97.9	2.1	48
		18	1786	97.7	0.0	97.7	0.0	43
		27	1734	100.0	0.0	100.0	0.0	44
		36	1914	86.4	9.1	95.5	0.0	44
		Total	**6623**	**74.2**	**2.2**			**178**
	12	12	2208	2.1	0.0	39.6	27.1	48
		24	2564	30.6	12.2	61.2	4.1	49
		36	2781	24.5	46.9	26.5	36.7	49
		Total	**7554**	**19.2**	**19.9**			**146**

Table 4 Predicted Gross margins ($/head) over 36 months for fleeces shorn 9- or 12-monthly at each of two sites, using five sets of prices.

(Prices obtained using WoolCheque for 2002, 2003, 2004 and 2005 seasons or a commercial valuer)

				9 Month		12 Month	
Price basis	**Site**	**Site mean**	**se**	**Predicted**	**se**	**Predicted**	**se**
2002	Central	136.28	(4.29)	141.34	(5.84)	131.23	(6.30)
	Southern	131.89	(4.09)	130.43	(5.98)	133.34	(5.59)
2003	Central	133.75	(3.90)	131.33	(5.31)	136.17	(5.72)
	Southern	131.44	(3.72)	128.36	(5.43)	134.53	(5.07)
2004	Central	95.40^{b}	(2.33)	97.11^{B}	(3.17)	93.69^{B}	(3.41)
	Southern	86.02^{a}	(2.22)	81.53^{A}	(3.24)	90.50^{B}	(3.03)
2005	Central	82.33^{b}	(1.85)	80.35^{AB}	(2.52)	84.31^{A}	(2.72)
	Southern	65.56^{a}	(1.77)	55.29^{C}	(2.58)	75.84^{B}	(2.41)
Commercial	Central	78.74^{b}	(1.86)	82.36^{A}	(2.56)	75.12^{A}	(2.69)
	Southern	52.49^{a}	(1.76)	45.14^{C}	(2.56)	59.84^{B}	(2.42)

$^{a, b}$ Different superscripts within each price basis indicates a significant (P<0.05) difference between the site means

$^{A, B, C}$ Different superscripts within each price basis indicates a significant (P<0.05) difference between the shearing interval means within each site.

Table 5 Age and growth period effects on the repeatability of staple length growth.

Growth period (mths)	Age (mths)	Growth: At age:	3 mths 3 mths	6 mths 6 mths	9 mths 9 mths	9 mths 12 mths	12 mths 12 mths	tip shearing 3 mths
tx3*	3		0.734					
6	6		0.509					0.502
9	9		0.535	0.376				0.622
9	12		0.132	0.308	0.720			0.216
12	12		0.403	0.410	0.657	0.769		0.323
9	18		0.315	0.298	0.694	0.738	0.720	
9	21		0.181	0.215	0.511	0.595	0.455	
12	24		0.178	0.056	0.556	0.677	0.604	
9	27		0.352	0.090	0.729	0.698	0.636	
9	30		0.186	0.099	0.401	0.475	0.305	
9	36		0.133	0.223	0.472	0.582	0.341	
12	36		0.000	0.000	0.193	0.258	0.085	

*** From the tip shearing patch at 3-months of age**