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ANALYSIS OF THE CURVATURE OF WOOL OFFERED FOR AUCTION IN AUSTRALIA

By

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SUMMARY

INTRODUCTION

This paper summarises curvature results for Australian sale lots presented at auction between July 2000 and December 2001. The curvature results for Australian sale lots have become available following the introduction of Laserscan measurement of fibre diameter.

Curvature results have been combined with other information from the auction catalogue such as region, AWEx ID appraisal and auction price to give a description of curvature across breed, styles and selling centres.

An analysis of the curavture results, and the relationship of curvature to some appraised characteristics are presented. The commercial implications of introducing curvature into commercial contracts, including available weight and auction price, are discussed.

METHODOLOGY

Sale lot information was collected on each Australian sale lot that was offered at auction between July 2000 and December 2001. The information included core test results and staple measurements from AWTA. The measurement of fibre diameter using Laserscan provided curvature measurements, in addition to the fibre diameter statistics.

Test information was combined with other sale and appraisal information on the sale lot. The other information included regional information, AWEx appraisals, sale details and auction price. The AWEx ID was used to provide breed, wool type and style information.

It is estimated that about 85% of all Australian wool production is sold through the auction system. Therefore it is assumed that the following results provide a reasonable and unbiased sample of the Australian wool clip.

A total of approximately 740,000 sale lots were used in the analysis.

Diameter classes refer to the median diameter ± 0.5 µm. Curvature classes refer to the median curvature ± 5°/mm.

Statistics were generated on a sale lot basis. Therefore the standard deviation (SD) used in the paper is the standard deviation of curvature between sale lots within the defined classes.

RESULTS

Summary statistics

The average curvature for all Australian sale lots offered at auction between July 2000 and December 2001 was 94.4°/mm. The SD of curvature between sale lots was 11.4°/mm.

The frequency distribution of curvature for all sale lots is shown in Table 1. The majority of the sale lots are within the curvature range of 60 to 150°/mm . The total distribution is slightly skewed to the low curvature end.

Average curvature is related to the average fibre diameter in Australian auction sale lots. Table 2 shows curvature statistics for each diameter class between 17 and 27 µm. The curvature is reduced as diameter increases, and the curvature variation decreases within the diameter class as the diameter increases.

Relative frequency distribution of curvature within these diameter classes is shown in Figure 1. There are skewed distributions for 18 and 19 µm sale lots, but the broader diameter classes appear to have normal distributions.

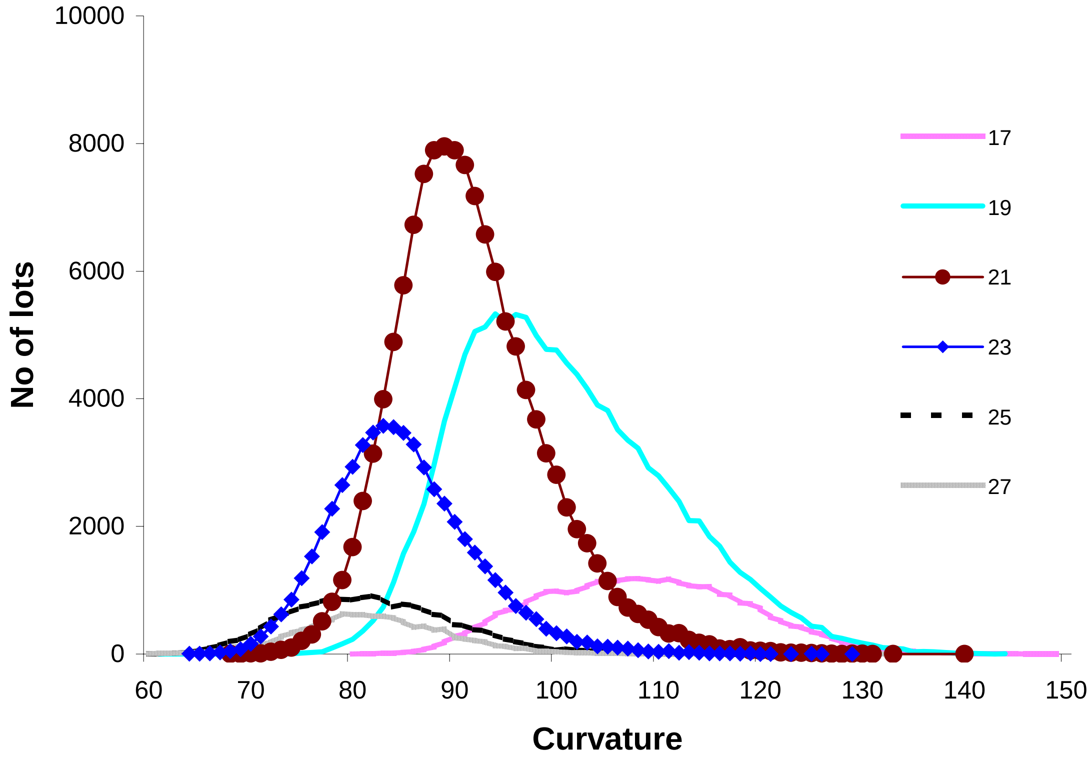
Table 1. Frequency distribution of curvature in Australian sale lots.

curvature class	No of lots	Relative Frequency
60	436	0.1%
70	18508	2.5%
80	141298	19.1%
90	282554	38.2%
100	173582	23.5%
110	83280	11.3%
120	33059	4.5%
130	6273	0.8%
140	581	0.1%
150	19	0.0%
sum	739590	100%

Table 2. Average and SD of curvature within diameter classes for Australian auction sale lots.

diameter class	number of sale lots	average curvature	SD	maximum curvature	minimum curvature
17	32242	108	10.0	149	80
18	86293	105	10.7	150	75
19	129914	101	10.1	144	61
20	140415	95	8.3	147	71
21	127746	91	7.1	167	68
22	93104	88	6.8	130	64
23	56484	85	6.9	129	64
24	32444	83	7.3	152	62
25	18227	82	8.0	130	60
26	12089	82	8.1	138	60
27	10633	82	7.3	132	58

Figure 1. Relative frequency distribution of curvature for Australian sale lots with diameters between 17 and 27 µm



Curvature and fibre diameter by breed

Table 3 shows the average curvature for the breed categories recognised in the AWEx ID wool types. As these breeds have differing diameter distributions, the results are presented within diameter classes. As the AWEx ID makes a destinction between the Australian Superfine (AS) sale lots and the Merino sale lots (M), the results in Table 3 keep these two classes separate.

In the finer diameter classes, the superfine merino has the highest average curvature, followed by the merino. The merino has a higher average curvature than the crossbreds in the 18 to 21 µm classes, but lower curvature over 22 µm. As expected the Downs breeds have a higher curvature than both the merino and the crossbred at any diameter.

Curvature and style for merino fleece wool

Average curvature in merino adult fleece wool changes with both mean fibre diameter and style. The style value is taken from the AWEx ID for merino sale lots. The effect of changing these two characteristics together is shown in Table 4. As style improves towards style=1, the average curvature increases within the diameter classes finer than 22 µm.

Curvature by Australian selling centres

Genetic and environmental differences in the types of wool from various regions of Australia can give rise to specification differences between the Australian wool selling centres. Average curvature results for each selling centre are presented in Table 5, together with the average fibre diameter.

Table 3. Average curvature for Australian sale lots, using the AWEx ID to provide breed information, and AWTA test results for average diameter and curvature.

diameter	superfine merino	merino	cross-bred	downs
17	117	109		
18	116	107	96	
19	113	101	95	
20	110	95	95	
21		90	91	108
22		87	90	94
23		83	88	95
24		80	87	92
25		77	85	97
26		73	83	97
27		70	81	95

Table 4. Average curvature for Australian merino fleece sale lots by style and by diameter classes.

	Style						
Diameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**
17	124	123	116	111	104	99	97
18	125	122	113	109	100	97	102
19		114	109	105	96	95	92
20		111	102	98	93	92	94
21			95	92	90	90	90
22			88	87	87	87	86
23			84	83	84	84	84
24			75	79	81	81	81
25			77	76	77	78	80
26				73	74	75	83
27				72	71	69	74

Table 5. Average curvature and fibre diameter by Australian selling centres.

Selling centres	number of sale lots	average curvature	SD curvature	average fibre diameter
Brisbane	47483	92	8.7	20.8
Fremantle	134969	92	8.5	20.5
Launceston	9294	99	12.8	19.6
Melbourne	254758	92	10.9	21.0
Newcastle	60162	106	12.0	19.0
Sydney	232925	96	11.5	20.5

The high curvature results are evident in Newcastle and Launceston, but these are associated with a lower average fibre diameter. Therefore it does not seem reasonable to attribute curvature differences to the selling centres.

Curvature and fibre diameter for merino fleece wool types

Changes in curvature are evident in the different merino fleece types. Curvature results were assembled by fleece type (adult, weaners and lambs) using the AWEx ID. These categories represent fleeces from animals of different ages. As the AS and M classifications both refer to adult fleece wool, they have been combined in the results shown in Table 6.

Table 6. Curvature for Australian merino fleece sale lots, sold between July 2000 and December 2001.

diameter	adult	weaner	lambs
17	111	106	99
18	108	100	94
19	102	95	90
20	95	91	87
21	90	89	84
22	87	86	83
23	83	84	84
24	80	83	89
25	77	86	86
26	73	83	81
27	70	83	-

The highest average curvature results are in the adult fleece category, especially in the finer diameters below 21 μm. The average curvature for wool less than 22 μm is lower within a given diameter for weaners and for lambs.

DISCUSSION

The analysis of curvature shows that it is related to other raw wool characteristics, and can change between wool types. However curvature does not appear to be able to replace any of the measured (such as diameter) or appraised (such as style) characteristics because the variance of curvature within these classes is high. This is seen in the use of curvature in the delivery of Elite wools in combination with diameter as part of the initial selection criteria for raw wool. It is also interesting that the Elite wools are identified on the basis of low curvature for a given diameter, whereas the style results (Table 4) show high styled wool with high curvature. Curvature therefore has the ability of being sought in the high and low ranges for any given diameter.

Initial use of curvature by industry will most probably be as an additional specification in the raw wool which would impact on the quality of end-product or efficiency of processing intermediate products. So this discussion of curvature in the Australian raw wool supply will focus on the impact of introducing curvature into commercial selections for raw wool consignments.

Curvature in contracts: effect on supply

Curvature results can be used to define mill requirements when assembling raw wool sale lots from auction. However the introduction of additional constraints on the selection of sale lots (in this case constraining curvature) will restrict the number of suitable sale lots. To illustrate the effect of introducing curvature terms into commercial contracts, two typical consignment specifications have been prepared for 18 and 21 μm mill deliveries. Then different curvature range constraints have been applied, and the clean weight of wool available under each condition is recorded. This has been repeated for each of the 18 months to examine the effect over time.

The 18 μm contract was selected over a range of +/-0.5 μm, a staple length between 75 and 95 mm, staple strength over 35Nktex, and VM<1.5%. Only adult merino fleece sale lots that were sold at auction were used. Assembly was from all selling centres. The same specifications were used for the 21 μm contract.

Table 7 shows the 18 μm results where curvature was restricted to upper curvature ranges, because there is some discussion that lightweight worsted knitwear manufactures prefer high curvature wool. The results show that the weight of wool available changes most significantly when lower curvature limits of 105 and 115 are applied. Below this limit the weight changes from the maximum weight are small. When higher limits are applied, the weight availability is significantly reduced, and approaches zero.

Table 7. Weight of Australian merino fleece wool available in the 18 μm selection by month when lower limits are placed on curvature specifications. Weight is in tonnes of clean wool.

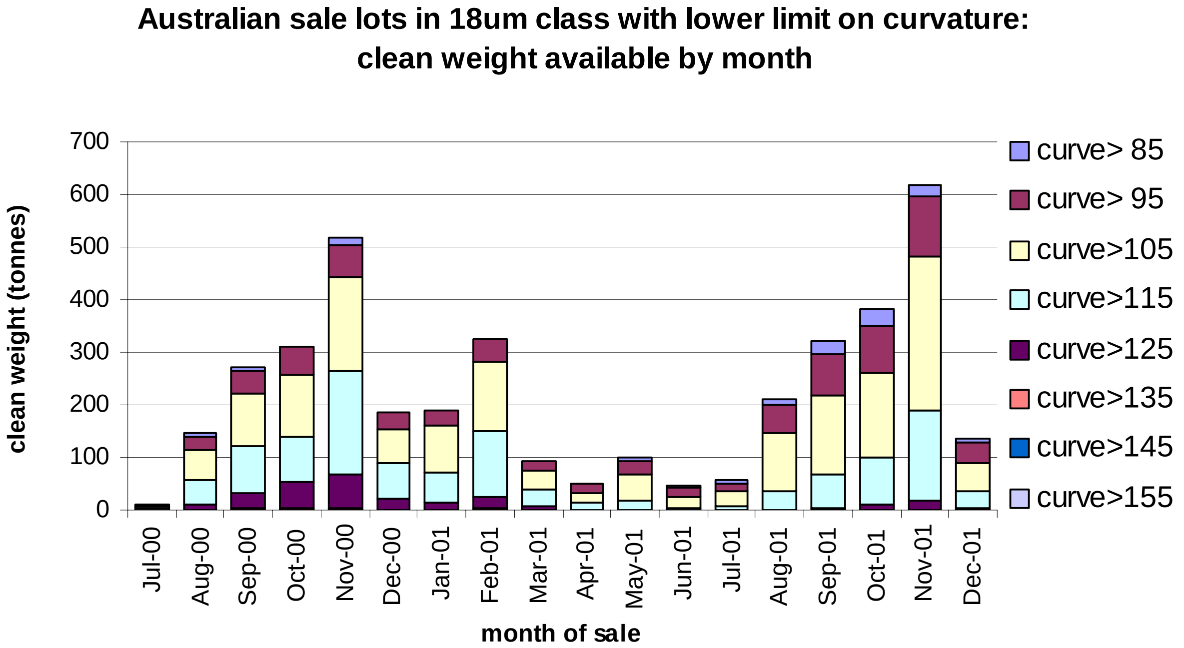
	lower limit					
Date	**> 85**	**> 95**	**>105**	**>115**	**>125**	**>135**
Jul-00	11	11	7	4	0	0
Aug-00	145	139	114	58	12	1
Sep-00	270	266	221	121	34	5
Oct-00	312	312	258	138	53	3
Nov-00	517	505	442	263	68	5
Dec-00	185	185	153	88	21	0
Jan-01	189	189	161	72	15	1
Feb-01	324	324	281	149	27	2
Mar-01	93	93	74	39	6	0
Apr-01	50	50	33	14	2	0
May-01	101	91	67	17	2	0
Jun-01	47	42	25	4	2	0
Jul-01	58	51	36	7	0	0
Aug-01	211	200	145	36	1	0
Sep-01	322	297	217	67	3	0
Oct-01	382	351	261	101	12	1
Nov-01	618	597	482	189	16	0
Dec-01	137	128	88	34	3	0

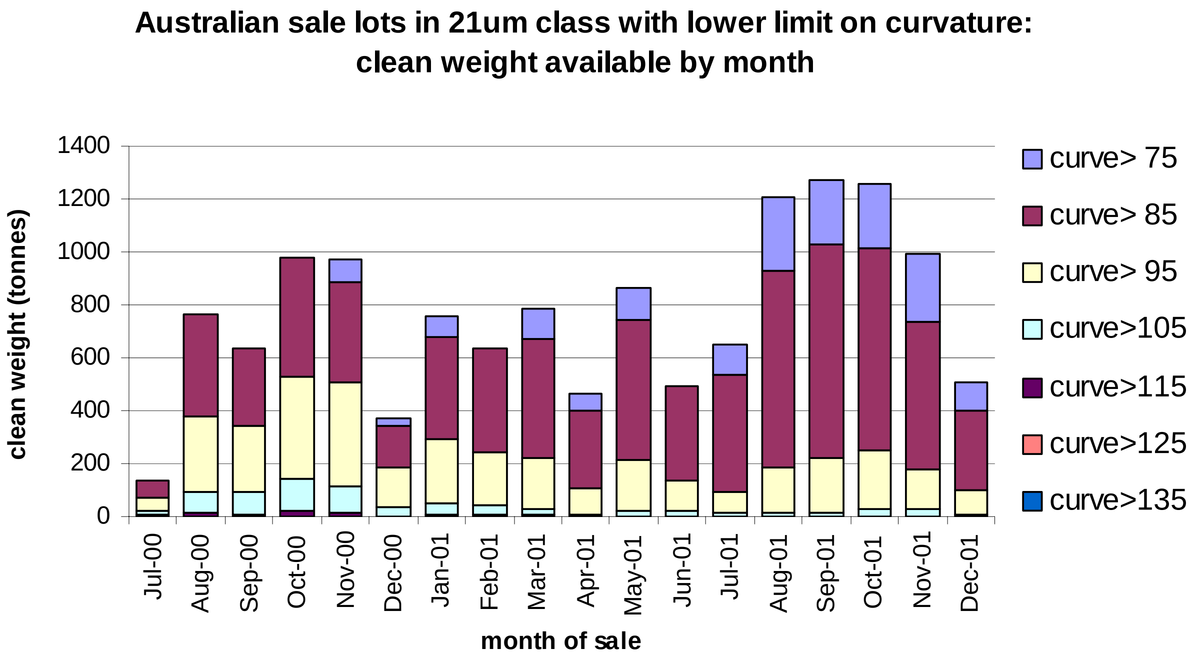
The analysis was repeated for the 21 μm selection. The same pattern exists, but the major changes in weight occur when applying lower curvature limits of 85.

The results from Table 7 are presented in Figure 2 show the total weight available per month for the 18 μm selection. The partitions within the vertical bars represent the reduction in available wool when the curvature limits are introduced. The largest partitions (change in weight) occur when the curvature limits of 105 and 115 are applied. The same information for the 21 μm selection is also shown in Figure 2

These results also show that there is a change occuring over time in the available weight of wool at each curvature limit. There is no evidence within the dataset as to the cause of the change over time, but given the timeframe in which the changes occured, the effect might be due to seasonal effects. This can be confirmed later when more information is available.

Figure 2. Weight of Australian merino fleece wool availabe in the 18 and 21 μm selection by month when lower limits are placed on curvature specifications. Weight is in tonnes of clean wool.





Curvature and clean auction price

There is discussion about the benefits of curvature in processing and on end-product quality. If these benefits are recognised by the processors, then some preference for curvature in raw wool, possibly through the association of curvature, style and crimp, should be evident in the auction prices.

An examination of auction prices was undertaken for the 18 and 21μm wool selections that were defined above. The average clean auction price was calculated by month for different curvature classes within the 18 and 21 μm wools. A selling period of September to November 2001 was selected because it was relative stable market period and there was a significant weight of wool being sold. All selling centres were included. Table 8 shows the number of sale lots sold, and the average clean price for 18 and 21 μm wool types over a range of curvature classes.

Table 8. Average clean auction price for 18 and 21 μm selections of Australian merino fleece sale lots of differing curvatures, sold between September and November 2001. The table shows the number of sale lots in each category, and the average price for these lots in Australian cents per clean kg.

	18 μm selection		21 μm selection	
curvature	**number**	**price**	**number**	**price**
70	-	-	12	639
80	6	1103	802	664
90	152	1199	2210	665
100	675	1397	659	668
110	1400	1558	85	667
120	754	1677	10	676
130	99	1819	-	-
140	4	1804	-	-

The average prices increase as the curvature increases within the 18 μm range. There appears to be no price change with curvature within the 21 μm range. This would suggest that there is an increase in demand for high curvature fine wool. It also suggests that there is no increase in demand for low curvature wool in fine wool. Curvature is not a component of demand for 21 μm fleece wool.

These price results are included to indicate that some price change can be associated with curvature changes. However the authors do not suggest that this table demonstrates the exact relationship between curvature and price. A full analysis of curvature effects on auction prices, including senitivities to other raw wool characteristics, and yarn market segments, is beyond the scope of this paper.

The results presented in this paper are from the first 18 months of the measurements available on Australian sale lots. Therefore the results are representative of a short term cross section of the Australian supply. In this period the total supply is at the lowest level over the last 10 years, and any increase in weight will have the potential to change the balance of wool types reaching the auction market, and the distribution of curvature results within the expanded supply.

CONCLUSIONS

The curvature results of Australian sale lots has been described in detail. Changes in curvature have been associated with changes in breed within the Australian clip. Within merino sale lots, curvature changes with diameter and style, reaching maximum average curvatures for very fine, high styled merino sale lots.

The quantity of wool of a given diameter available in Australian auctions will change rapidly over a small curvature range. This has significant implications when setting contract specifications.

Preliminary examination of auction prices suggest that in 18 μm sale lots, the auction price increases with an increase in curvature. There was no such effect of curvature on price at 21 μm.