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Processing of Classed Grower and Bulk Class Lots of Different Uniformity Index

By

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SUMMARY

Mini consignments of wools matched for measured Raw Wool properties, but with different Uniformity Indices, were processed to top at CSIRO, Textile and Fibre Technology. The findings were:

- No real differences were noted between the wools with different UI's in either their processing performance or in the quality of their tops for the quality characteristics measured.
- There were no differences between the preparation of the Sale Lots, i.e., whether Classed Grower or Bulk Class, in processing performance or product quality for the quality characteristics measured.
- The CV (Diameter) values of the Sale Lots which comprised each processing batch determined the CVD of the resulting tops, i.e. a raw wool blend composed of lots with low CVD's produced a top with a low CVD and vice versa.
- All tops had a consistently lower CVD than the combination of the Greasy wool blend. This lower CVD may be due to the preferential removal of fine wool in combing.
- The Hauteur, CV (Hauteur) and romaine of the blends were all well predicted by the TEAM equations.

1 BACKGROUND

The International Wool Textile Organisation (IWTO) Core Test Regulations[1] define different classes of wool lots based on wool preparation category. Test houses are required to identify the preparation category on IWTO Certificates. In response to industry concerns regarding the accurate identification of any category of wool, particularly Bulk Classed (BC) versus Classed Grower (CG) lots, AWTA Ltd developed the Uniformity Index (UI)[2]. In simple terms this index is a measure of the variability of the lot, with a low index indicating low variability, and a high index indicating high variability.

The UI was obtained using Multiple Regression Analysis and is based on measures of Coefficient of Variation of Staple Length (CVL), Coefficient of Variation of Staple Strength (CVS), Coefficient of Variation of Diameter (CVD), and variation in Position of Break (Uniformity of POB). In previous papers submitted to IWTO[2,3], there was a distinct separation of the Uniformity Index of Bulk Classed lots and Classed Grower lots.

Earlier, Thompson et al[4] noted the slightly increased variability of Staple Length (SL) for Bulk Classed versus Classed Grower lots and suggested that these differences would produce no significant

differences in processing performance. The Cooperative Research Centre (CRC) for Premium Quality Wool expressed an interest in assessing the effect, if any, the Uniformity Index had on the processing performance of wool lots. A feasibility trial was designed to investigate how mini consignments matched for measured raw wool characteristics, but with differences in Uniformity Index, would perform during early stage processing. This document reports on that trial.

2 AIM

To determine the effects on Early Stage Processing of differences in UI for 'mini-consignment' blends composed of fleece wool lots matched closely for Mean Fibre Diameter (MFD), Staple Length (SL), Staple Strength (SS) and Vegetable Matter Base (VMB).

3 METHOD

3.1 Assembly of Processing Blends

Four (4) processing blends were assembled with the following criteria:

- Low UI Bulk Class (all lots having a UI <40)
- High UI Bulk Class (all lots having a UI > 40)
- Low UI Classed Grower (all lots having a UI < 40)
- High UI Classed Grower (all lots having a UI > 60)

The blends were created through an accumulation of grab (display) samples obtained from Australian Wool Handlers (AWH). Each grab sample was a fleece lot and satisfied the specifications listed in Table 1. The Uniformity Index was calculated for each grab sample and was the final criteria in determining the suitability of a sample for the trial.

Table 1. Specifications of Component Grab Samples

	Blend Mean	Component Range
Mean Fibre Diameter (um)	21	+/-2
Staple Length (mm)	95	+/-15
Staple Strength (N/ktex)	32	27-40
Vegetable Matter (%)	1	0-5

Approximately 40 grab samples were obtained for each blend in order to achieve a desired blend weight of 200kg.

3.2 Sampling and Testing of Processing Blends

Duplicates were created for each processing blend, making a total of 8 blends for processing.

Each display sample was divided into equal halves by randomly assigning consecutive handful-sized portions to A and B replicate processing batches. The A and B samples were weighed to ensure that there was an equal representation of each. At this stage replicate staples were selected from each replicate batch (parts A and B) (refer to the Appendix for details of the sampling procedures).

After all the component sale lots in a processing blend were assembled, the wool was pressed into a pack and hand cored to achieve approximately 150g of cored wool from each processing batch. This core sample was tested for: wool base, VM base, MFD, CVD, Fibre Curvature and Average Yellowness.

Testing of these samples provided two estimates of the raw wool properties of each mini consignment, i.e. one from the hand cored sample and another from the combination of the Certified testing results for each lot in the consignment.

3.3 Processing

All batches were blended by hand at CSIRO, Textile and Fibre Technology (TFT).

"Wastieness" values, including a detailed mass balance, were calculated for each batch to provide estimates of the actual yield of top and noil, as well as providing a breakdown of card waste values.

Fibre Diameter, Fibre Curvature, fibre length parameters, and Nep and VM counts were measured for each top.

4 RESULTS

4.1 Procurement of wools

A major achievement of these trials was the procurement of wools to meet the tight technical specifications. High UI CG lots were relatively easy to obtain, but given the specification limits, high UI BC and low UI CG were difficult to obtain. This difficulty is not surprising since the UI was specifically designed to separate lots by method of preparation into CG at high values and into BC at low values. Table 2 lists the details of the display sample lots acquired for the trial. The average values were obtained according to the combination procedures listed in IWTO-31-98[5].

Table 2. Details of the component Display Samples used in the processing blends.

		Classed Grower		Bulk Class		
Blend Parameters		**Low UI**	**High UI**	**Low UI**	**High UI**	**Target Value**
MFD (µm):	mean	21.2	21.1	21.5	21.2	21.0
	min	19.3	19.4	19.7	19.2	19.0
	max	22.9	23.0	23.0	22.8	23.0
VM (%):	mean	1.5	0.8	1.2	0.9	1.0
	min	0.1	0.1	0.2	0.2	0.1
	max	4.7	2.9	6.2	2.0	5.0
Staple Length (mm):	mean	90	93	88	89	95
	min	80	81	80	82	80
	max	104	104	96	93	110
Staple Strength (N/ktex):	mean	32	34	33	33	32
	min	27	27	27	27	27.0
	max	75	45	47	43	40.0
M* (%):	mean	49	79	53	57	na
	min	45	45	45	45	na
	max	70	98	69	70	na
Fibre Curvature (deg/mm):	mean	88	87	84	90	na
	min	73	72	72	73	na
	max	108	105	103	102	na
Uniformity Index:	mean	36	77	33	47	na
	min	26	64	18	40	na
	max	41	86	40	62	na
No. of Sale Lots		40	48	35	33	na
TEAM Hauteur + 4 (mm)		73	71	72	71	na

na: not applicable

4.2 Repeatability of replicate batches.

The variation in measured properties between replicate batches is shown in Table 3. These results were obtained from the hand-cored sample and hand sampled staples taken from each processing batch. In each case the difference between the replicates is within the published variation for the Test Method, indicating that it is unlikely that there is a significant difference between the replicate batches for any of the parameters tested.

Table 3. Between batch variation in wool testing parameters

		Classed Grower		Bulk Class	
Blend Parameters		**Low UI**	**High UI**	**Low UI**	**High UI**
Wool Base:	Batch A	58.8	62.4	58.9	57.1
	Batch B	59.3	62.3	58.9	58.0
	Mean	59.1	62.4	58.8	57.5
	Difference	0.5	-0.1	0	0.9
MFD (µm):	Batch A	21.6	21.0	20.9	21.6
	Batch B	21.1	21.3	21.1	21.2
	Mean	21.4	21.1	21.0	21.4
	Difference	-0.5	0.3	0.2	-0.4
VM (%):	Batch A	1.5	0.8	1.0	1.3
	Batch B	1.1	0.7	0.8	1.2
	Mean	1.3	0.8	0.9	1.2
	Difference	-0.4	-0.1	-0.2	-0.1
Staple Length (mm):	Batch A	96	96	95	93
	Batch B	97	97	94	93
	Mean	96	96	93	93
	Difference	1	1	-1	0
Staple Strength (N/ktex):	Batch A	31	33	32	28
	Batch B	30	32	31	31
	Mean	31	32	31	30
	Difference	-1	-1	-1	3
M* (%):	Batch A	42	71	38	41
	Batch B	47	70	42	47
	Mean	44	71	40	44
	Difference	5	-1	4	6
Fibre Curvature (deg/mm):	Batch A	85	89	90	85
	Batch B	88	89	90	88
	Mean	86	89	90	86
	Difference	3	0	0	3

The parameters for top quality are shown in Table 4 for the average of each processing batch. There was no difference (to the nearest whole number) between the values of H and CV(H) between the replicate pairs of processing batches for each processing blend. Similarly there was no difference in MFD to the nearest 0.1µm. The maximum differences for CVD and Fibre Curvature (FC) between the replicate pairs were 0.8% and 5 degrees/mm, respectively.

Table 4. Average top quality for the 4 processing batches, showing the differences in various quality parameters measured.

	Classed Grower			Bulk Class		
Top Parameters	**Low UI**	**High UI**	**Diff**	**Low UI**	**High UI**	**Diff**
MFD (µm)	21.2	21.1	0.1	21.4	21.1	0.3
CVD (%)	22.9	21.6	1.3	23.2	23.4	-0.2
Fibre Curvature (deg/mm)	74	75	-1.0	68	72	-4
Hauteur (mm) A	74	73	1.0	73	73	0
CV - Hauteur (%)	47	50	-3.0	47	47	0
VM/100g (<3mm)	35	34	1.0	37	37	0
VM/100g (>3<10mm)	8	2	6	7	6	1
VM/100g (>10mm)	8	2	6	7	6	1
Neps/100g	53	49	4	36	36	0
Romaine (%)						
Predicted (TEAM)	7.3	6.1	-1.2	6.8	7.0	-0.2
Measured	7.6	6.6	-0.6	7.5	7.4	0.1

The Romaine measurements are included in this table for completeness but they are discussed in section 4.4.

The lower Nep count for the Bulk Class lots is unexpected. The formation of neps is generally related to MFD, with some research indicating that wools with a better Crimp Definition may produce fewer neps. There was no difference in MFD between the batches and while it is unlikely that the Bulk Class lots had a better Crimp Definition, no information was collected on this characteristic. Likewise there was no information on Crimp Frequency.

4.3 Differences from expected values

Table 5 shows the average measured values for top parameters and the combined raw wool data for each processing blend, and the differences between the raw wool and top values. The raw wool parameters used in the TEAM prediction (i.e., MFD, SL, SS, M* and VM) were calculated using the combination procedures outlined in IWTO-31-98[5].

The very small differences between the measured and the expected values for the diameter and length parameters in Table 5 indicate that neither the UI nor the method of Sale Lot preparation, i.e. Classed Grower or Bulk Class, had any measurable effect on top quality.

When considered in detail, the differences between the measured and expected (TEAM) values of Hauteur for the High UI consignments were 1mm longer than for the Low UI consignments. But these differences between the High UI and Low UI batches, although consistent, are very small and unlikely to be significant. Indeed, if the alternative set of raw wool measurement data (i.e., from the hand sampling of the processing batches) are used, slightly different values are derived for the differences between the High UI and Low UI batches. In this case the differences were: 1 and –3 for the High UI batches; and, –2 and –1 for the Low UI batches.

A further important finding about top quality from these trials concerns CVD. The CVD values of the Sale Lots that comprised each processing batch determined the CVD of the top produced from that batch. Batches composed of Sale Lots with relatively high CVD (approximately 23.6%), processed into the tops with relatively high values of CVD, approximately 23.3%. In a similar manner, the batch whose component Sale Lots had relatively low values of CVD, approximately 21.7%, produced a top with a CVD of 21.6%.

Table 5. Comparison between values for a combined raw wool blend and values in a top

		Classed Grower		Bulk Class	
Wool Parameters		**Low UI**	**High UI**	**Low UI**	**High UI**
MFD (µm)	Greasy wool	21.2	21.1	21.5	21.2
	Top	21.2	21.1	21.4	21.1
Difference	(Top – Greasy)	0	0	-0.1	-0.1
CVD (%)	Greasy wool	22.8	21.7	23.6	23.6
	Top	22.8	21.6	23.2	23.4
Difference	(Top – Greasy)	0.0	-0.1	-0.4	-0.2
Hauteur (mm)	TEAM*	73	71	72	71
	Measured	74	73	73	73
Difference	(Measured – TEAM*)	1	2	1	2
CVH (%)	TEAM	49	54	49	50
	Top	47	50	47	47
Difference	(Measured – TEAM)	-2	-4	-2	-3

TEAM*: Includes a mill adjustment of 4mm.

4.4 Processing losses

There was no consistent pattern between the High UI and Low UI batches, in the differences between the measured and predicted processing losses.

Table 6 lists the measured and the expected losses[6] during carding (burr beater only) for each processing blend. Generally losses are related to vegetable matter (VM) removal. The amount of VM removal is related to VM type as well as the amount of VM in the wool. Different VM types may contribute to the small differences amongst the 4 blends.

Table 6. Measured and Expected Carding Losses

	Classed Grower		Bulk Class	
Burr beater Loss (%)	**Low UI**	**High UI**	**Low UI**	**High UI**
Predicted	2.9	1.4	2.3	1.7
Measured	3.4	2.2	3.5	2.9
Difference (Measure – Predicted)	-0.5	-0.8	-1.2	-1.2

Table 7 shows the measured romaine and the TEAM prediction of romaine for each processing blend. All four batches had slightly higher values for romaine than were predicted by TEAM. The differences between the measured and predicted values are each so small that it is difficult to conclude that either the UI or the source of the wool (Grower or Bulk Class) had any effect on the value of romaine in this trial.

Table 7. Measured and Expected Romaine for each processing blend.

		Classed Grower		Bulk Class	
Romaine (%)		**Low UI**	**High UI**	**Low UI**	**High UI**
	Predicted (TEAM)	7.3	6.1	6.8	7.0
	Measured	7.6	6.6	7.5	7.4
Difference	(Measured – TEAM)	0.3	0.5	0.7	0.4

5 CONCLUDING REMARKS

There was no difference in the processing performance or quality of the resultant top, of the batches in this trial. Within the precision of the measurements used, no effects were discernable of UI, or of the method of preparation of Sale Lots, on early stage processing when batches were matched for MFD, SL, SS and VMB.

Since the processing batches used in this trial were matched extremely closely for MFD, SL, SS and VMB, it is unlikely that it will be possible in the future to measure any effect of UI on early stage processing for wools with these properties.

Other observations from the trial were:

- The values of CVD for the component Sale Lots of a batch determined the CVD of the resulting top, i.e. a batch composed of lots with a low CVD (e.g. 21.5%) resulted in a top with a CVD of approximately 21.5%, whereas a batch composed of higher CVD lots (e.g. 23%) resulted in a top with a CVD of approximately 23%.
- The TEAM predictions for Hauteur were very close to the measured values. All batches had small differences (0.3 to 1.7mm) from their TEAM predictions for Hauteur. The raw (uncorrected) predictions of CV of Hauteur from the TEAM equation were also consistent, being 2%-4% higher than the measured values.
- All tops had a consistently lower CVD than the combination of the Greasy wool blend. This lower CVD may be due to the preferential removal of fine wool in combing. The noil was finer than the top for each of the batches processed.

6 ACKNOWLEDGEMENTS

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CSIRO, Textile and Fibre Technology, provided the batching, sampling, assembling and processing of the blends, and the testing of the resulting top. A special thanks is due to Dr Peter Lamb for coordinating the work at CSIRO and for his helpful input during the analysis of the results.

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7 REFERENCES

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APPENDIX 1

SAMPLING PLAN FOR UI PROCESSING BATCHES

Aim:

Batch and sample each of the 8 processing batches from the UI trial.

The following 8 processing batches are required:

Blend 1 batches A and B;

Blend 2 batches A and B;

Blend 3 batches A and B;

Blend 4 batches A and B.

The following 16 sets of staples are required:

Blend 1 batches A1, A2, A3, A4, B1, B2, B3 and B4;

Blend 2 batches A1, A2, A3, A4, B1, B2, B3 and B4;

Blend 3 batches A1, A2, A3, A4, B1, B2, B3 and B4;

Blend 4 batches A1, A2, A3, A4, B1, B2, B3 and B4.

A set of 8 core samples is required with the same source and identifications as used for the staples.

Method:

1. Batching

Isolate all the Display Samples for each of the 4 UI categories, i.e. Blends 1 to 4. The numbers of Display Samples that comprise each category are:

Blend 1 – 40 Display Samples;

Blend 2 – 48 Display Samples;

Blend 3 - 33 Display Samples;

Blend 4 – 35 Display Samples.

Select all the Display Samples from one of the 4 UI categories, e.g. Blend1. Each display sample is to be divided into equal halves by randomly assigning consecutive handful-sized portions to A and B processing batches. The A and B samples should be weighed to ensure that there is an equal representation of each. It may be convenient at this stage to sample each half of the Display Sample (parts A and B) for staples (refer Section 2 for details).

Assemble the half-Display Samples into the appropriate A or B processing batches.

When all the Display Samples for the UI category are divided and assembled as 2 replicate processing batches, repeat the procedure outlined above on another of the UI categories. Continue sampling until all 4 categories have been assembled into the 8 processing batches, i.e. an A and a B batch for each of the 4 categories.

2. Sampling Staples

Using a Sampling Blanket (or Board) sample 8 staples from the A half of each Display Sample. Place the first and fifth staples selected into a staple tray for Replicate A1, place the second and sixth staples into a different staple tray for Replicate A2, place the third and seventh staples into a third tray for replicate A3 and place the forth and eight staples into a forth staple tray for Replicate A4.

Repeat the staple sampling procedure outlined above for the B half of the Display Sample.

Repeat the full staple sampling procedure for each successive Display Sample in the current UI category. Do not start a new staple tray for each successive Display Sample, staples should be simply added to the next available slot in the appropriate staple tray (e.g. Replicate A1). When the tray is full, simply start to fill a new tray and add a label for the appropriate identification, e.g. Replicate A1. The order of assignment of staples to replicate trays should be rotated for each successive sampling. That is, place the first and fifth staples selected into a staple tray for Replicate A2 and place the second and sixth staples into a different staple tray for Replicate A3, etc. for each alternate Display Sample.

3. Core Sampling

Press all of the wool required for each processing batch into 8 bales/butts, one bale/butt per processing batch. Hand core each butt to achieve approximately 150g of cored wool from each processing batch. Each core sample should be immediately double bagged, and identified. Use the same sample identification as used for the staple sampling, e.g. Blend1 batch A1.

APPENDIX 2

SPECIFICATIONS OF AVERAGE TOP QUALITY FOR THE 4 PROCESSING BATCHES

		Classed Grower			Bulk Class		
Top Parameters		**Low UI**	**High UI**	**Diff**	**Low UI**	**High UI**	**Diff**
MFD (µm)	Batch A	21.2	21.1	0.1	21.4	21.1	0.3
	Batch B	21.1	21.1	0.1	21.3	21.1	0.2
	Mean	21.2	21.1	0.1	21.4	21.1	0.3
CVD (%)	Batch A	23.0	22.0	1.0	23.3	23.3	0.0
	Batch B	22.7	21.2	1.5	23.1	23.5	-0.4
	Mean	22.9	21.6	1.3	23.2	23.4	-0.2
Fibre Curvature (deg/mm)	Batch A	76	73	3.0	66	72	-6
	Batch B	71	77	-6.0	69	73	-4
	Mean	74	75	-1.0	68	72	-4
Hauteur (mm)	Batch A	74	73	1.0	73	73	0
	Batch B	74	73	1.0	73	73	0
	Mean	74	73	1.0	73	73	0
CV - Hauteur (%)	Batch A	47	50	-3.0	47	47	0
	Batch B	47	50	-3.0	47	47	0
	Mean	47	50	-3.0	47	47	0
VM/100g (<3mm)	Batch A	34	31	3.0	39	48	-9
	Batch B	35	37	-2.0	35	26	9
	Mean	35	34	1.0	37	37	0
VM/100g (>3<10mm)	Batch A	9	3	6	10	4	6
	Batch B	8	1	7	4	7	-3
	Mean	8	2	6	7	6	1
VM/100g (>10mm)	Batch A	1	3	-2	0	1	-1
	Batch B	0	2	-2	1	0	1
	Mean	1	3	-2	1	1	0
Neps/100g	Batch A	63	54	9	42	38	4
	Batch B	44	45	-1	30	34	-4
	Mean	53	49	4	36	36	0
Romaine (%)							
Predicted (TEAM)		7.3	6.1	1.2	6.8	7.0	-0.2
Measured		7.6	6.6	1.0	7.5	7.4	0.1
Difference (Measured – TEAM)		0.3	0.5	-0.2	0.7	0.4	0.3