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TEAM-3 Processing Trial: November 2003 Update

By

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SUMMARY

This report provides a further update on the progress of the TEAM-3 trial. The results are very similar to previous reports presented to IWTO. The results continue to show that processing performance has improved since the late 1980's and that mills are producing tops with Hauteur values, on average, 4.8 mm longer than is predicted by the TEAM-2 general formula. Larger differences occur as the Hauteur increases above 75 mm. In addition, mills are producing tops which have, on average, CV of Hauteur values 2.3 % less than predicted by the TEAM-2 formula and Romaine values which are, on average, 2.0 % greater than predicted. With regards to core/comb relationships, the mean fibre diameter of the top is, on average, 0.22 μm coarser than the mean fibre diameter of the greasy wool.

A statistical analysis was conducted on 505 consignments that were submitted by 31 mills as part of the TEAM-3 trial. The analysis shows that the effects of Staple Length, Staple Strength, Fibre Diameter and Mid Breaks on Hauteur are similar for both the TEAM-2 and the TEAM-3 databases. Using the current TEAM-3 data, the inclusion of CV of Diameter and CV of Length in the regression model results in a small improvement in the prediction of Hauteur. However, based on the data available, fibre curvature does not have a determinable influence on the processing prediction of these 505 consignments.

INTRODUCTION

This is the fourth successive paper presented to IWTO which provides an update on the progress of the TEAM-3 trial. The first report (Lindsay *et al*, 2002a) summarised the data from 163 commercial processing consignments, the second report (Lindsay *et al*, 2002b) was based on 313 consignments, and the third report (TEAM-3 Steering Committee, 2003) was based on 453 consignments. The TEAM-3 database has continued to expand and this fourth report examines the data from 505 commercial consignments.

At the time of writing, a total of 31 mills have submitted 546 commercial consignments. The global distribution of the processing mills participating in TEAM-3 is illustrated in Table 1. There are 37 mills listed in Table 1 who have signed an agreement to participate in this trial, although to date not all mills have submitted consignments. This report provides a snapshot of current processing practice by examining the results of 505 of these consignments. It was not possible to provide a report on the entire database as further analysis of submitted top samples is required before the data can be included in any report.

Table 1. TEAM-3 Participating Mills (as at November 2003)

Country	Mills	Country	Mills
Australia	7	Japan	1
China	11	Korea	1
Czech Republic	1	Singapore	1
France	2	Slovak Republic	1
Germany	1	Taiwan	1
India	5	Thailand	1
Italy	3		

CONSIGNMENT DETAILS

A summary of the major raw wool and processing characteristics of the TEAM-2 and TEAM-3 databases (as at November 2003) is presented in Table 2 and Table 3 respectively. The TEAM-3 data reported in the tables is derived from 505 consignments totalling 120,904 bales of greasy wool. In contrast, the TEAM-2 database totalled 603 consignments.

Table 2. Range and Mean of the Raw Wool Characteristics of Consignments

	TEAM-1 & TEAM-2 Total Database			TEAM-3 Database (November 2003)		
	Avg	**Max**	**Min**	**Avg**	**Max**	**Min**
Schlumberger Yield (%)	--	--	--	69.28	78.05	57.44
Mean Fibre Diameter (μm)	22.0	31.0	17.0	20.3	24.9	16.4
Staple Length (mm)	86	123	59	85	104	71
CV Length (%)	19	30	12	18	28	14
Staple Strength (N/ktex)	39	60	23	38	50	24
Tip Breaks (%)	--	--	--	21	54	2
Mid Breaks (%)	--	--	--	52	86	28
Base Breaks (%)	--	--	--	26	64	6
Vegetable Matter Base (%)	2.1	10.0	0.1	1.2	5.3	0.3
CV of Diameter (%)	--	--	--	21.8	25.2	19.1
Mean Fibre Curvature (deg/mm)	--	--	--	93	124	74
Comfort Factor (%)	--	--	--	97.1	99.5	85.4

Table 3. Range and Mean of the Processing Characteristics of Consignments

	TEAM-1 & TEAM-2 Total Database			TEAM-3 Database (November 2003)		
	Avg	**Max**	**Min**	**Avg**	**Max**	**Min**
Hauteur (mm)	67	97	48	73	91	58
CV of Hauteur (%)	49	61	31	45	58	33
Romaine (%)	8	21	1	9.0	18.1	2.3
Top & Noil Yield (%)	64	77	46	70.4	79.6	59.0
Mean Fibre Diameter (μm)	22.1	31	17	20.6	25.4	16.4
CV of Diameter (%)	--	--	--	21.2	25.1	17.3
Comfort Factor (%)	--	--	--	96.9	99.8	82.8

The range data depicted in Tables 2 and 3 is shown graphically in Figures 1 to 14.

Figure 1: TEAM-3 SDRY Yield Histogram

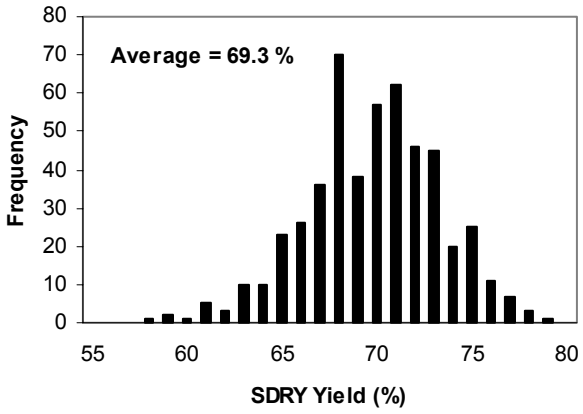


Figure 2: Team-3 VMB Histogram

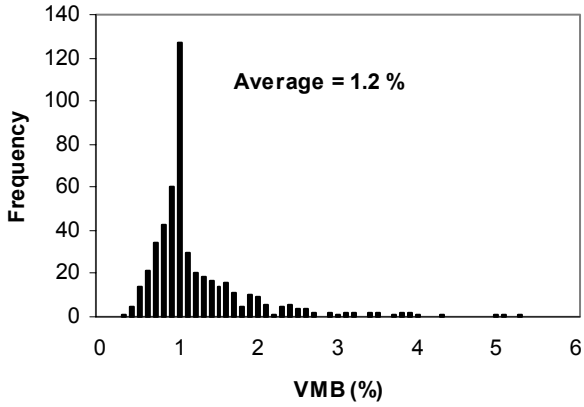


Figure 3 : TEAM-3 Mean Fibre Diameter Histogram

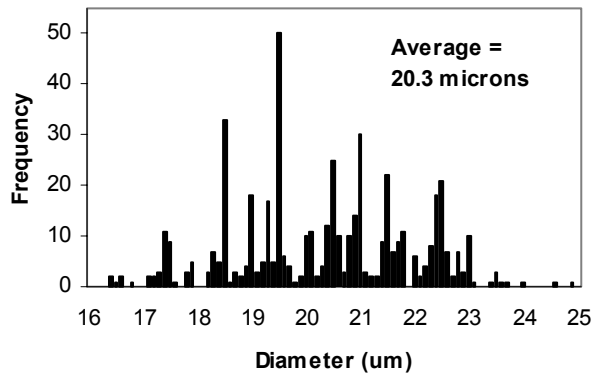


Figure 4: TEAM-3 CV of Diameter Histogram

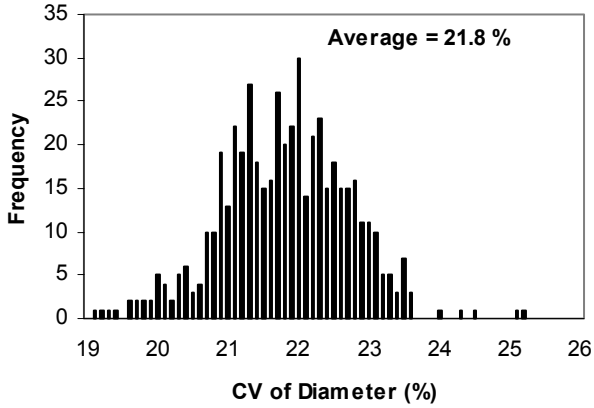


Figure 5: TEAM-3 Fibre Curvature Histogram

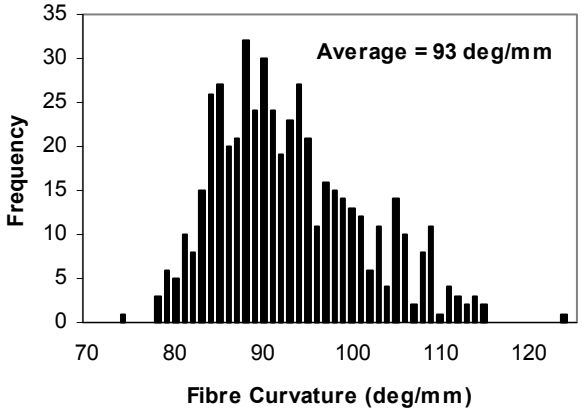


Figure 6: TEAM-3 Staple Length Histogram

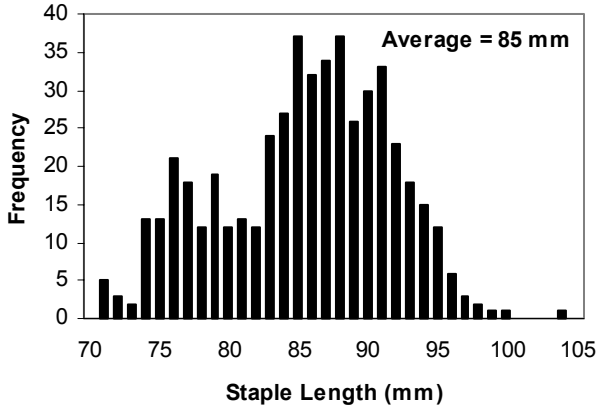


Figure 7: TEAM-3 CV Staple Length Histogram

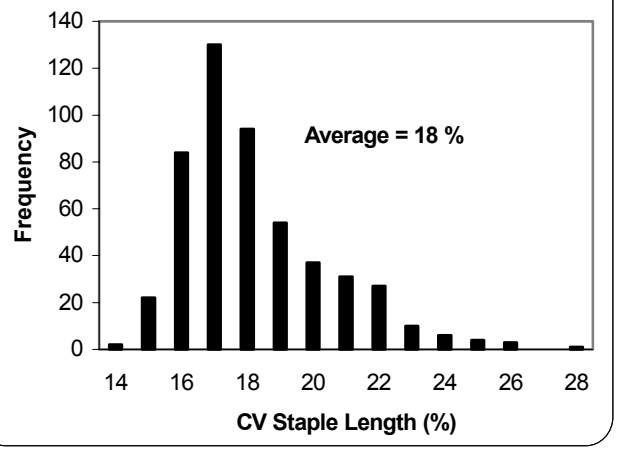


Figure 8: TEAM-3 Staple Strength Histogram

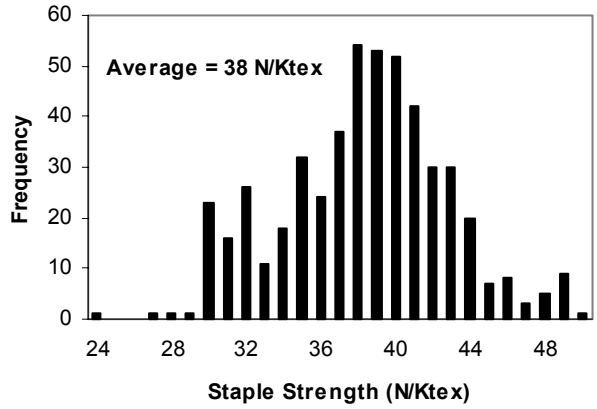


Figure 9: TEAM-3 Tip Break Histogram

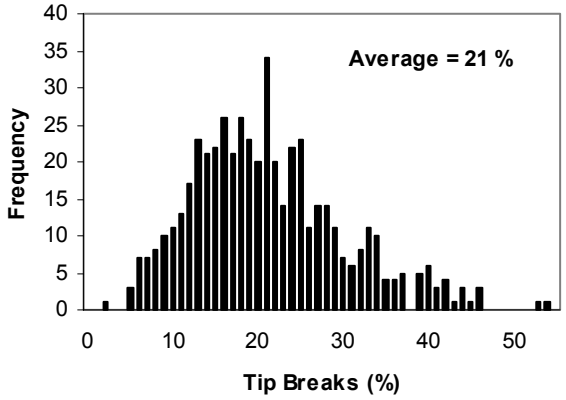


Figure 10: TEAM-3 Mid Break Histogram

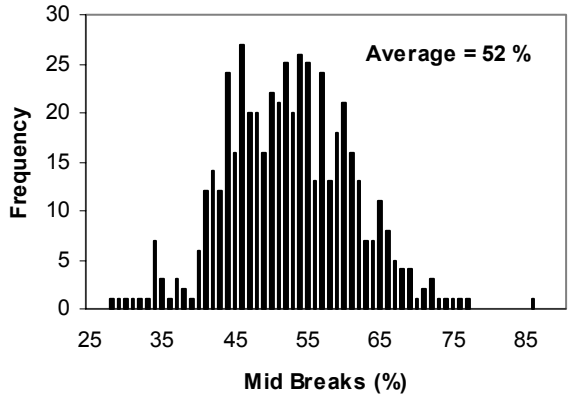


Figure 11: TEAM-3 Base Break Histogram

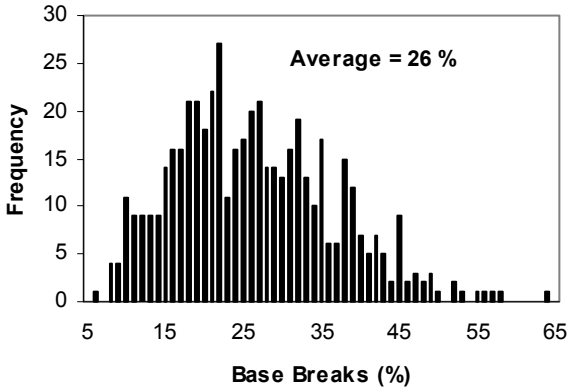


Figure 12: TEAM-3 Hauteur Histogram

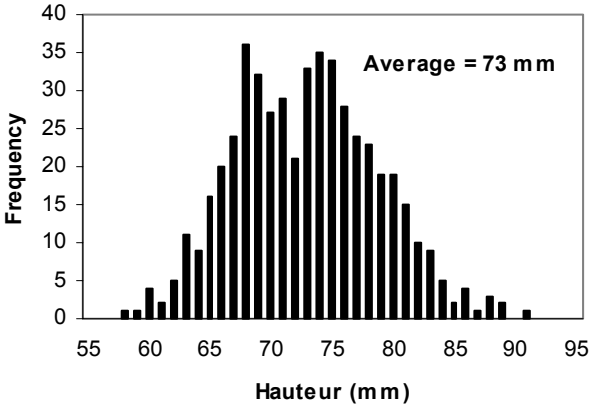


Figure 13: TEAM-3 CV Hauteur Histogram

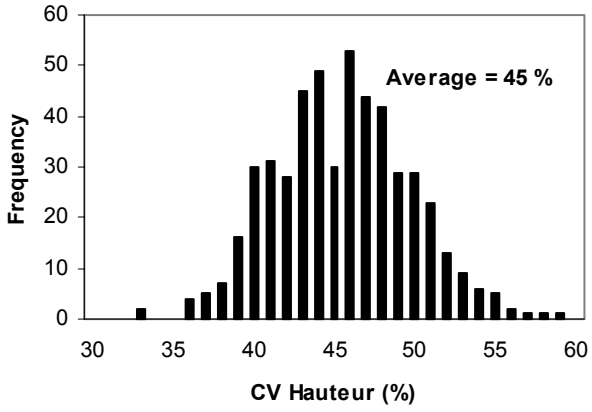
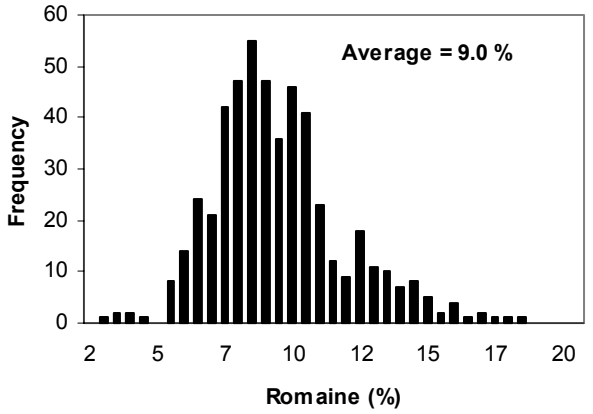


Figure 14: TEAM-3 Romaine Histogram



In the report sent to the Buenos Aries Congress of IWTO, the TEAM-3 Steering Committee (2003) discussed in detail the differences between the ranges of the TEAM-2 and TEAM-3 data sets. It should be noted that the ranges of the TEAM-3 consignments are largely unchanged since this report was written.

PROCESSING PERFORMANCE AND COMPARISON TO TEAM-2

Based on the data from 505 commercial consignments, the average difference between actual Hauteur and TEAM-2 predicted Hauteur is 4.8 mm (Table 4). The difference between actual and predicted Hauteur reported at the Buenos Aries Congress was 4.9 mm.

In terms of CV of Hauteur, actual values are, on average, 2.3% less than predicted by TEAM-2. For Romaine, actual values are 2.0% greater than predicted by TEAM-2. Both of these comparisons are unchanged since the Buenos Aries Congress.

Table 4. Comparison between Actual and Predicted Hauteur, CV of Hauteur and Romaine (Derived from 505 TEAM-3 processing consignments).

	HAUTEUR (mm)			CV of HAUTEUR (%)			ROMAINE (%)		
	Actual	Predicted*	Diff.	Actual	Predicted*	Diff.	Actual	Predicted*	Diff.
Mean:	72.5	67.6	4.8	45.1	47.4	-2.3	9.0	7.0	2.0
St Dev:	6.1	5.0	3.7	4.2	3.0	3.1	2.5	1.5	1.6

* Note: Predicted using TEAM-2 general formulae (1988)

Figures 15-17 show graphically the differences between actual and predicted Hauteur, CV of Hauteur and Romaine. The slopes on these three graphs confirm that processing performance has changed significantly over the past 15 years. The slope effects suggest that simple mill adjustments will not adequately compensate for these differences. However, individual mill effects must be investigated before new prediction formulae can be recommended for each of these parameters.

Although the average difference between actual Hauteur and TEAM-2 predicted Hauteur is 4.8 mm, Figure 15 shows that the differences are larger for Hauteur values in excess of 75 mm. The average difference between actual and predicted Hauteur is 7.1 mm for all those consignments with an actual Hauteur of 75 mm or greater. Approximately 33% of the 505 consignments submitted have Hauteur values of 75 mm or greater.

Figure 15. Hauteur Differences (Actual - TEAM2)

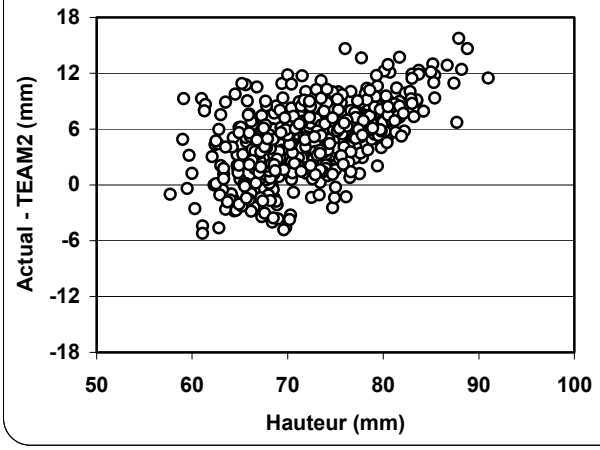


Figure 16. CV Hauteur Differences (Actual - TEAM2)

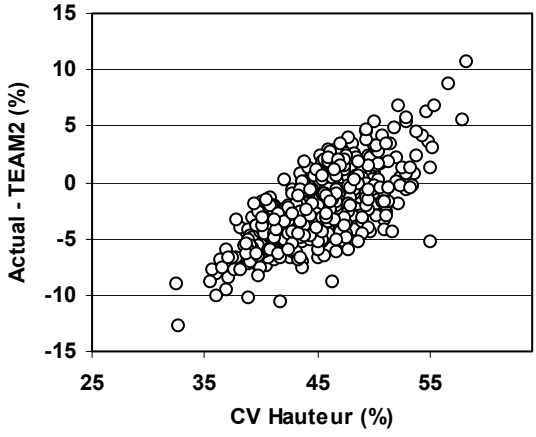
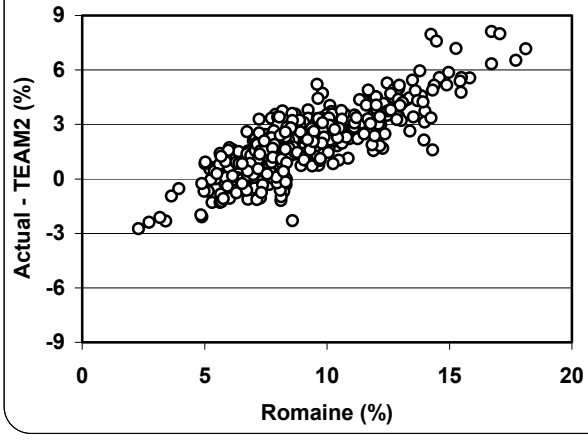


Figure 17. Romaine Differences (Actual - TEAM2)



CORE/COMB RELATIONSHIPS

Figure 18 shows the relationship between the core mean fibre diameter and the top mean fibre diameter for the 505 commercial processing consignments. For each processing consignment submitted as part of the TEAM-3 trial, a minimum of five samples of top are provided to AWTA Ltd for analysis. The diameter of the top that is used in this analysis is that measured by AWTA Ltd, using Laserscan. As such, Figure 18 shows a direct comparison between the Laserscan core result and the Laserscan top result. On average, the mean fibre diameter of the top is 0.22 μm coarser than the mean fibre diameter of the greasy wool. The core/comb comparison reported at the Buenos Aries Congress (TEAM-3 Steering Committee, 2003) was 0.24μm.

Figure 18. Core/Comb Fibre Diameter Comparison

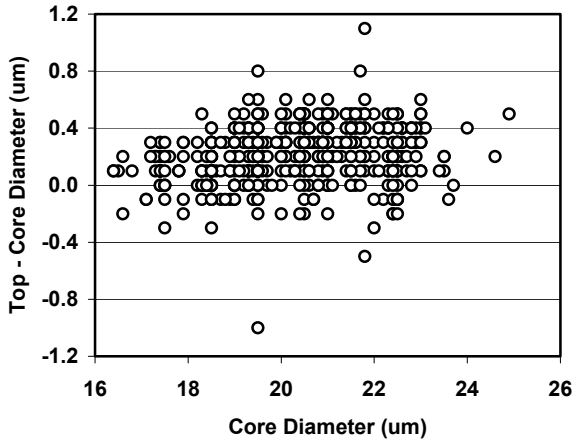
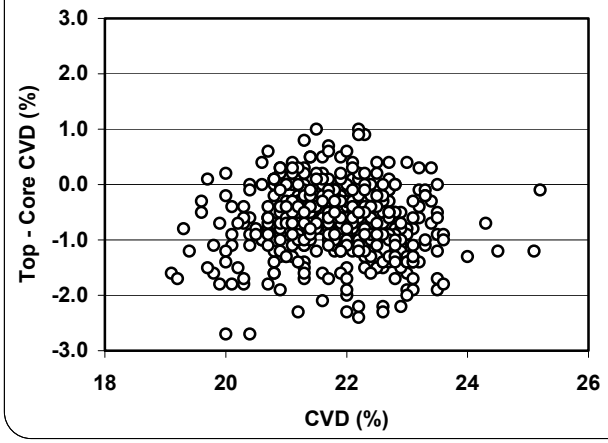


Figure 19 compares the CV of Diameter of the greasy wool and the top. It shows that the CV of Diameter is, on average, 0.7% lower in the top than it is in the core. This is an expected result as processing is understood to remove proportionally more fine fibres than coarse fibres as noil. This has the effect of increasing the fibre diameter in the top (Figure 18) and decreasing the fibre diameter variation in the top. This result is similar to that reported at the 2003 Buenos Aries Congress where the difference was 0.6%.

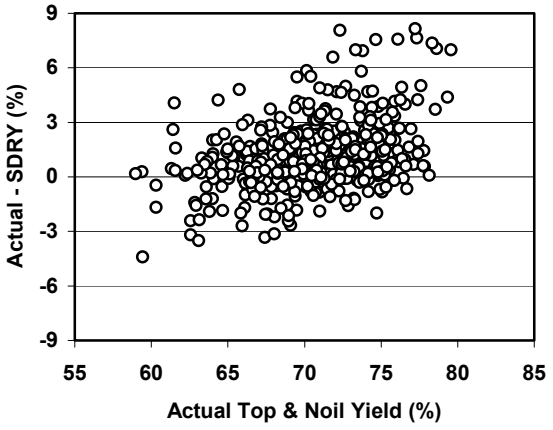
Figure 19. Core/Comb CV of Diameter Comparison



YIELD COMPARISON

A comparison between the actual Top and Noil yield achieved by the processing mills and the predicted yield using the Schlumberger Dry Top and Noil Yield (SDRY) formula is shown in Figure 20. On average, the actual yield is 1.1% higher than the yield predicted by the SDRY formula. The difference reported in Buenos Aries was 1.2%.

Figure 20. Yield Comparison



STATISTICAL ANALYSIS OF TEAM-3 DATA

The data from the consignments submitted for the TEAM-3 trial was analysed using the S Plus statistical package. As with the reports presented to IWTO in 2002 and 2003, the analysis included re-determining the coefficients for the current TEAM formula for Hauteur and then adding either one, two or three new variables to the model. The variables added were Mean Fibre Curvature (MFC), CV of Diameter (CVD), and CV of Length (CVL). Eight different multiple regression analyses were conducted which plotted Hauteur against the factors shown in Table 5.

For reference, the TEAM-2 general equation, as published in 1988, is as follows:

$$H = 0.52L + 0.47S + 0.95D - 0.19M^* - 0.45V - 3.5 + [MA1]$$

Where: H = Hauteur (mm); D = Mean Fibre Diameter (μm); L = Staple Length (mm); S = Staple Strength (N/ktex); V = Vegetable Matter Base (%); M* = Adjusted percentage of middle breaks; MA1 = Mill Adjustment Factor

Table 5 is of identical format to the table presented in earlier TEAM-3 reports (Lindsay *et al*, 2002a, Lindsay *et al*, 2002b, TEAM-3 Steering Committee, 2003). Regression 1 is an analysis of the TEAM-3 database using Staple Length (SL), Staple Strength (SS), Fibre Diameter (D), Adjusted Mid Breaks (M*) and Vegetable Matter Base (V) as a function of Hauteur. These are the same coefficients that formed the basis of the TEAM-2 equation. It is noticeable that the regression analysis on the TEAM-3 database gives a lower Standard Error (SE) than was reported for TEAM-2, suggesting improved repeatability.

The coefficients for SS, SL, D and M* are similar between TEAM-2 and Regression 1. The coefficient for V is not statically significant and, as has been mentioned in previous TEAM-3 reports, this is most likely due to the small range of VMB in the database. In the current TEAM-3 database, 90% of all consignments have a VMB of 2% or less (See Figure 2 for VMB range histogram).

Table 5. Statistical Analysis using Additional Factors of CVD, MFC and CVL to predict Hauteur.

Regression		SL	SS	D	M*	V	CVD	MFC	CVL	SE (mm)	R^2
	TEAM-2	0.52	0.47	0.95	- 0.19	- 0.45				3.4	84%
1	TEAM-3	0.58	0.49	1.09	-0.17	***(-0.01)***				2.72	80%
2	TEAM-3 +CVD	0.47	0.34	1.48	-0.19	***(-0.14)***	-1.07			2.67	81%
3	TEAM-3 + MFC	0.58	0.49	0.97	-0.17	***(-0.01)***		***(-0.03)***		2.73	80%
4	TEAM-3 + CVL	0.47	0.45	1.33	-0.16	***(0.23)***			-0.44	2.66	81%
5	TEAM-3 + CVD + MFC	0.47	0.34	1.23	-0.19	***(-0.14)***	-1.15	***(-0.06)***		2.67	81%
6	TEAM-3 + CVD + CVL	0.39	0.33	1.61	-0.18	***(0.09)***	-0.87		-0.37	2.63	81%
7	TEAM-3 + MFC + CVL	0.47	0.45	1.16	-0.16	***(0.24)***		***(-0.04_***	-0.44	2.66	81%
8	TEAM-3 + CVD + MFC + CVL	0.39	0.33	1.35	-0.18	***(0.10)***	-0.95	***(-0.07)***	-0.38	2.62	82%

Note: All coefficients that are not statistically significant are bracketed in Italics and Bold.

THE ADDITION OF NEW VARIABLES TO THE TEAM MODEL

Although the coefficients have changed slightly from the previous TEAM-3 analysis, the trends shown are the same. The addition of CVD (Regression 2) and CVL (Regression 4) improve the processing prediction model with the SE and the R^2 improving slightly over Regression 1. The addition of Fibre Curvature (MFC) to the model (Regression 3) did not result in any improvement to the prediction of Hauteur.

It should be noted that the analysis above refers to the prediction of Hauteur only. The final TEAM-3 report will also examine the prediction of CV of Hauteur and Romaine.

CONCLUSIONS

This report has provided an update on the progress of the TEAM-3 trial. It has been shown that processing performance has improved since the late 1980's and that mills are producing tops with Hauteur values, on average, 4.8 mm longer than is predicted using the TEAM-2 general formula. Larger differences occur as the Hauteur increases above 75 mm. In addition, mills are producing tops with CV of Hauteur values, on average, 2.3% less than predicted by TEAM-2 and Romaine values 2.0% greater than predicted. The level dependencies identified in the TEAM-3 database would indicate that there is likely to be potential for an improvement in processing prediction.

The core/comb comparison for the data set shows that the diameter of the top is, on average, 0.22 μm coarser than the diameter of the core. In addition, the CV of diameter decreases by 0.7% in the top.

Using the current TEAM-3 data, the inclusion of CV of Diameter and CV of Length in the regression model results in a small improvement in the prediction of Hauteur. However, based on the data available, fibre curvature does not have a determinable influence on the processing prediction of these 505 consignments.

The TEAM-3 trial will conclude early in 2004. It is likely that a final report on this industry project will be presented to the Evian conference of IWTO in 2004. In this report, all data will be presented together with any recommendations with regards to amendments to the existing TEAM formulae.

ACKNOWLDEGEMENTS

The authors would like to acknowledge David Crowe (AWTA Ltd) for his assistance with the statistical analysis.

REFERENCES

Douglas, S.A.S. and Couchman, R.C. (1997). Industry Review of the TEAM Prediction Formulae. *International Wool Textile Organisation. Woolgrowers, Traders & Early Processors Committee*. Nice Meeting, December 1997.

Garnsworthy, R. Mayfield, R., Gully, R., Westerman, R. and Kenins, P (1985) Mechanisms in Cutaneous Sensations of Prickle and Itch Evoked by Fabrics, the 7th International Wool Textile Research Conference, Tokyo, III, 190.

IWTO-DTM-60-01, The Woolmark Company, UK.

Lindsay, A.R., Marler, J.W., and Jackson, M.A. (2002a). Preliminary Analysis of TEAM-3 Database. *International Wool Textile Organisation. Raw Wool Group*. Barcelona Meeting, May 2002 Report 4.

Lindsay, A.R., Marler, J.W., and Jackson, M.A. (2002b). TEAM-3 Progress Report (December 2002). *International Wool Textile Organisation. Commercial Technology Forum*. Nice Meeting, December 2002 Report CTF 02.

Mahar, T.J., O'Keefe, J.M.A. and Couchman, R.C. (2002), A preliminary Report on the Use of Raw Wool Measurements to Predict Fibre End Characteristics of Top, *International Wool Textile Organisation. Technology & Standards Committee*, Barcelona, SG01.

TEAM-3 Steering Committee (2003). TEAM-3 Processing Trial – May 2002 Update. *International Wool Textile Organisation. Commercial Technology Forum*. Buenos Aries Meeting, May 2003 Report CTF 04.

Trials Evaluating Additional Measurement (1988). Report to the Raw Wool Measurement Research Advisory Committee of the Australian Wool Corporation, December 1988.