The Influence of Measurement Interval and Grease on OFDA2000 Profile Characteristics

C. M. Gloag and R. Behrendt

Department of Natural Resources and Environment, Pastoral and Veterinary Institute, Hamilton, VIC 3300
clare.gloag@nre.vic.gov.au

Summary

OFDA2000 technology has the capacity to rapidly generate fibre-diameter profiles. These profiles illustrate changes in fibre diameter throughout the wool growth period and are of interest to some producers, as farm management practices can influence profile shape and therefore potentially alter the value of the wool. However, it is unclear whether profiles generated on the OFDA2000, where scanning occurs every 5mm, provide sufficient detail to detect small changes in fibre diameter. Also, the extent to which grease along the fibre influences the profile needs examination. To investigate these influences, 6 measurement methods on the OFDA2000 were trialed. Cleaned staples were measured at different intervals (2mm, 5mm and 10mm) using glass slides. Greasy (with and without a grease correction factor) and clean staples were also measured at 5mm intervals using fibreglass slides. Results indicated that, for profile information, the 2mm and 5mm interval measurements were similar while measurement at 10mm intervals provided insufficient detail of profile shape. There were some changes in the ranking of animals on fibre-diameter profile characteristics, further indicating some difference between measurement methods. It was concluded that scanning at 2mm intervals provides a more detailed profile and hence detects more subtle differences in profile shape. However, for most on-farm applications, scanning at 5mm intervals appears to be adequate. The use of grease correction must also be carefully considered, as the range in fibre diameter of each profile appeared to be lower compared to other measurement methods.

Introduction

An enhancement of the portable OFDA2000 device over existing wool-testing technology is its ability to generate a fibre-diameter profile along the wool staple. This profile illustrates the variation in fibre diameter throughout the wool growth period. As nutrition and management can alter the shape of the profile, and therefore influence other wool characteristics, such as staple strength (Peterson *et al.* 2000), this information is of potential interest to wool producers. When the standard fibreglass slide is used, the OFDA2000 builds a profile by plotting the average fibre-diameter measurements across the staple at 5mm intervals. The profile information is used by the OFDA2000 software to provide maximum and minimum diameter measured, the estimated break point based on the point of minimum fibre diameter, and standard deviation and coefficient of variation of fibre diameter along the fibre. This experiment was conducted to examine the differences in fibre-diameter profiles generated on the OFDA2000 through measurement at different intervals along the staple. It also investigated profile information generated from greasy staples in comparison to that generated from clean staples.

Materials and Methods

Mid-side samples taken from 95 adult merino ewes with 9.5 months of wool growth were used in this experiment. The samples were collected during a previous trial investigating the effect of immunisation against adrenocorticotrophic hormone and psycho-social stress on wool quality (Behrendt *et al.* 1992; Behrendt 1998). The experimental design gave rise to 4 different treatments (each with 25 animals), details of which are not provided here, given that the focus of this paper is the method of measurement. Throughout this paper, they will be referred to as treatment groups 1, 2, 3 and 4.

Three adjacent staples were drawn from each mid-side collected in the trial described above. One staple from each sample was set aside for later measurement on the OFDA2000 in a greasy state. The remainder were scoured in a solution of isopropanol and hexane as per the ratios recommended by the OFDA2000 manufacturer. Samples were scoured in a sonicator for 1 minute, excess solvent removed by rolling on a drying pad, then scoured for a second minute in the sonicator and rolled again. All staples were placed in an oven at 70°C to ensure the complete evaporation of solvent, before conditioning in a controlled environment (20°C ± 2°C; 65% ± 2% relative humidity) for a minimum of 24 hours. One clean staple from each mid-side was spread on a fibreglass slide and measured on the OFDA2000 with the humidity correction and grease correction factor (GCF) off. With the GCF still switched off, the greasy staple was measured. For each of the 4 treatments, a separate GCF was calculated by subtracting the clean fibre-diameter measurement from the greasy fibre-

diameter measurement of each mid-side and calculating an average difference. The staples from each treatment were re-measured with the calculated GCF. The second clean staple was spread onto a glass slide and measured 3 times at different intervals 2mm, 5mm and 10mm). When wool is measured using the fibreglass slides, the fibres are suspended in air between the fibreglass slats in contrast to the glass slides where the wool is measured through the glass.

Statistical Analyses

A linear mixed model including a cubic spline of distance from the tip of the staple (Verbyla *et al*. 1999), with estimation via REML (residual maximum likelihood), was fitted to the fibre-diameter data to test for effects of treatment groups and measurement intervals (fixed effects), while allowing for random animal effects. REML was used to assess average wool characteristics of the entire group (n = 95) with treatment groups and measurement intervals as fixed effects and animals as random effects. Spearman rank correlation coefficients were calculated to determine the differences in ranking of animals between test methods. All analyses were undertaken using Genstat 5.42 (GenStat Committee 2000).

Results

OFDA2000 Glass Slide Measurements

There were significant non-linear trends ($P < 0.05$) for treatment groups over distance (spline effect) for all measurement intervals. Hence, the departures from the linear trend are specific for each treatment group. A linear effect of treatment group by distance was also significant ($P < 0.05$) for the 2mm and 5mm measurement intervals; but for the 10mm, there was only a significant effect of distance ($P < 0.05$). Fitted profile trend lines illustrating changes in fibre diameter from the tip to base of the staple are shown for the 2mm, 5mm and 10mm intervals for each treatment group in Figure 1. Profiles generated from the 2mm and 5mm scans have sections of noticeable deviations in profile shape between 15mm and 40mm from the tip, compared to the 10mm scanning intervals that failed to show these differences.

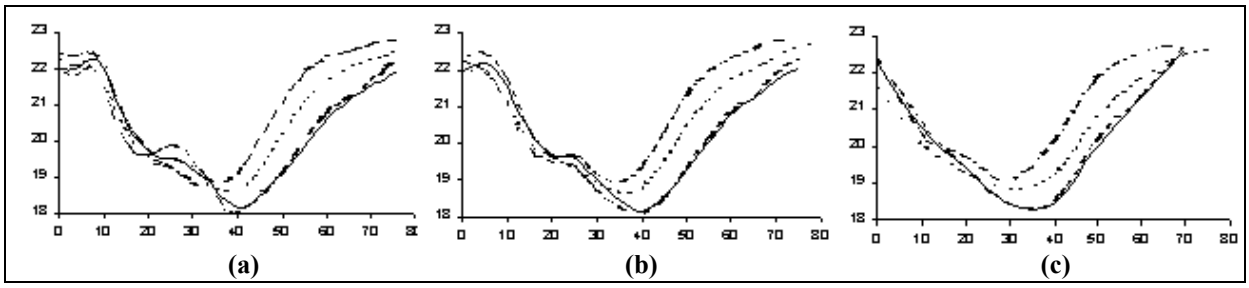

Figure 1. Profiles generated from the fitted cubic spline model for the (a) 2mm, (b) 5mm and (c) 10mm measurement intervals for treatment groups 1(—), 2(- -), 3(····) and 4(-·-).

When average wool characteristics of the entire group were analysed, no significant difference ($P > 0.05$) in the MFD, coefficient of variation in diameter (CVD) or staple length between measurement methods was detected (Table 1). There were, however, significant differences ($P < 0.05$) between some profile-related measurements for some of the measurement methods, supporting the trend lines fitted above.

Table 1. Predicted means for wool and profile characteristics measured at different intervals.

Characteristic	2mm	5mm	10mm	l.s.d. (p = 0.05)
MFD (μm)	20.31	20.35	20.39	0.42
CVD (%)	20.66	20.68	20.56	0.69
Staple length (mm)	70.90	70.68	69.47	1.85
Maximum diameter (μm)	23.04	22.77	22.52	0.47
Minimum diameter (μm)	17.96	18.08	18.29	0.43
Range (max.–min.) (μm)	5.08	4.69	4.23	0.29
Estimated break point (mm)	38.62	37.00	32.83	1.71

OFDA2000 Fibreglass Slide Measurements

There were significant non-linear trends ($P < 0.05$) for treatment groups over distance (spline effect) for the clean measurements and greasy measurements with no GCF. Therefore, with the exception of the greasy wool

measurements with the GCF applied, the departures from the linear trend are specific for each treatment group. A linear effect of treatment group by distance was also significant ($P < 0.05$) for all clean and greasy measurements. Fitted profile trend lines illustrating changes in fibre diameter from the tip to base of the staple are shown for the clean and greasy (with and without GCF) for each treatment group (Figure 2). The graph of the profiles when the GCF was applied is similar between treatment groups, supporting the statistical results above. In addition, the use of a GCF appears to narrow the range in fibre diameter along the staple.

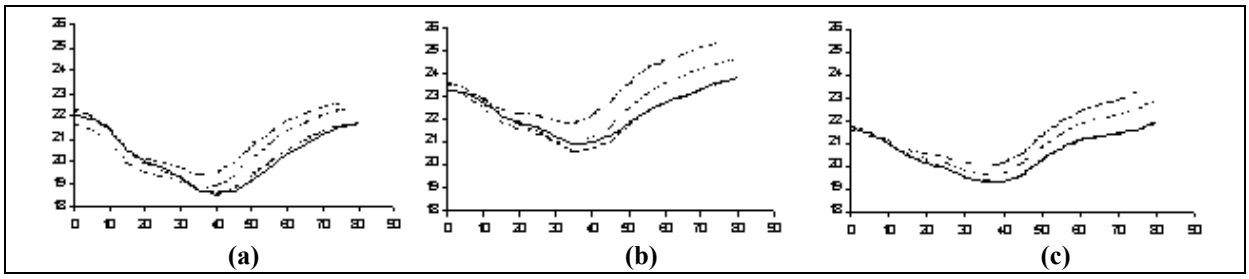

Figure 2. Profiles generated from the fitted cubic spline model for the (a) clean, (b) greasy (no GCF) and (c) greasy (with GCF) for treatment groups 1(—), 2(- -), 3(····) and 4(-·-).

When average wool characteristics of the entire group (n = 95) were analysed with treatment group as a fixed effect, there were significant differences ($P < 0.05$) in the MFD between greasy measurements and measurements on clean staples or greasy staples where a GCF was applied (Table 2). There also were differences between some profile-related measurements, supporting the trend lines fitted above.

Table 2. Predicted means for wool and profile characteristics measured greasy (with and without grease correction) and clean.

Characteristic	Clean	Greasy (no GCF)	Greasy (GCF)	l.s.d. (p = 0.05)
MFD (μm)	20.61	22.26	20.59	0.44
CVD (%)	19.37	19.41	18.80	0.59
Staple length (mm)	73.59	71.27	71.48	2.01
Maximum diameter (μm)	22.91	24.41	22.48	0.51
Minimum diameter (μm)	18.73	20.51	18.98	0.43
Range (max.–min.) (μm)	4.18	3.91	3.50	0.28
Estimated break point (mm)	38.76	35.75	36.51	2.45

Correlations Between Fibreglass Slide Measurements and Glass Slide Measurements

The correlations between measurement methods for MFD were highly significant ($P < 0.001$), indicating consistent ranking of animals between test methods, with the coefficients ranging between 0.91 and 1.0 (Table 3).

Table 3. Spearman rank correlation coefficients between rankings for the ewes based on mean fibre diameter (MFD).

	Glass 5mm clean	Glass 10mm clean	Fibreglass 5mm clean	Fibreglass 5mm greasy (no GCF)	Fibreglass 5mm greasy (GCF)
Glass 2mm clean	1.00	0.99	0.94	0.91	0.92
Glass 5mm clean		0.99	0.94	0.91	0.91
Glass 10mm clean			0.94	0.92	0.92
Fibreglass 5mm clean				0.95	0.95
Fibreglass 5mm greasy (no GCF)					0.99

Correlations for profile characteristics between all measurement methods ranged from moderate to high (r = 0.45 to 0.98). Spearman rank correlation coefficients were also highly significant ($P < 0.001$), indicating agreement between animal rankings based on different test methods (Table 4). From Table 4, it is evident that the correlation between measurement methods for minimum and maximum diameters was stronger than the correlation between fibre-diameter range or EBP.

Table 4. Spearman rank correlation coefficients between rankings for the ewes based on minimum diameter along the profile (Min.) (μm), maximum diameter along the profile (Max.) (μm), range in diameter (Range) (μm) and estimated break point (EBP) (mm).

		Glass 5mm clean				Fibreglass 5mm clean				Fibreglass 5mm greasy (GCF)			
		Min.	Max.	Range	EBP	Min.	Max.	Range	EBP	Min.	Max.	Range	EBP
Glass 2mm clean	Min.	0.97				0.91				0.90			
	Max.		0.97				0.93				0.88		
	Range			0.89				0.71				0.68	
	EBP				0.76				0.48				0.56
Glass 5mm clean	Min.					0.89				0.87			
	Max.						0.93				0.89		
	Range							0.70				0.58	
	EBP								0.51				0.55
Fibreglass 5mm clean	Min.									0.90			
	Max.										0.86		
	Range											0.52	
	EBP												0.49

Discussion

Decreasing the interval at which the OFDA2000 scans and measures the wool staple did not affect the ranking of animals on MFD. In this experiment, on average, measuring at 10mm intervals on the glass slide produced the same MFD result as measuring at 5mm, 2mm or 1mm intervals. Measurement of 2 further staples (greasy and clean) using fibreglass slides also produced similar results (when the calculated GCF was applied). This result is similar to the findings of Brown and Schlink (2002), who compared OFDA2000 profiles (measured at 3.5mm intervals) to profiles generated using 2mm snippet techniques. The measurement interval therefore only becomes important if the fibre-diameter profile information is of interest.

Given that the OFDA2000 has the capacity to provide profile information significantly quicker than conventional snippet techniques (Peterson and Gherardi 2001), interest in its use has increased (Baxter 2001). In this experiment, measurement interval had a significant influence on the prediction of profile shape. At 10mm intervals, the profile lacked sufficient detail to detect the significant interaction between experimental treatment and distance along the staple that measuring at 2mm and 5mm intervals could. The EBP was also significantly different; and a "flatter" profile was produced, reflected by a significantly lower average range in minimum and maximum diameter. While some significant differences in profiles were detected between the 2mm and 5mm measurement intervals, they were relatively small. Their importance would depend on the accuracy and precision required, as there is additional preparation and measurement time for the glass slides and therefore increased cost.

Results of this experiment suggest that the application of GCF to profile measurement should be used with caution due to the potential reduction in fibre-diameter range along the staple and apparent inadequacy in detecting differences in profile shape between experimental treatments. The best way to get detailed profile information and accurate measurement of wool characteristics is to measure the wool clean. However, if the profile shape is of interest and greasy wool is to be measured, it may be worth considering measurement without a grease correction. This of course will impact on the absolute values for fibre diameter and associated measurements, but relative differences will remain the same. The GCF may cause "flattening" of the profile due to some over-correction and under-correction on parts of the staple due to the variability of grease along the fibres. These effects appear to ultimately balance each other, as the mean fibre diameter on greasy wool with the grease correction applied is not significantly different from the mean fibre diameter of the clean wool. Variation in the estimated break point between greasy and clean measurements is likely to be a result of differences between staples and the effect of rolling the staples during the scouring process.

As there can be variation in profile characteristics between animals, if the profile characteristics of a small number of animals is to be measured, such as is the case with research experiments, the smaller measurement intervals may be the most applicable. Also, where small changes in fibre diameter need to be detected, it would be highly desirable to measure clean wool at more regular intervals to obtain a more detailed profile measurement. If animals were ranked on fibre-diameter profile characteristics, there would be good agreement if the ranking were based on MFD, minimum diameter or maximum diameter. However, if they were ranked on the

range in fibre diameter or EBP, then there would be differences in the ranking based on measurement method. Brown *et al.* (2000) and Brown and Schlink (2002) reported similar correlations. Differences are in part due to variation between staples. However, some variation exists between measurement method on the same staple as was detected when 2mm and 5mm glass slide measurements were correlated.

For broader industry use, where often a large number of animals are measured, the current standard practice of measuring at 5mm intervals appears to be adequate. However, further work is required on the application of GCF to profile measurements on greasy staples.

Acknowledgments

The authors thank Gavin Kearney for his assistance with the statistical analysis. The Department of Natural Resources and Environment Wool Strategy provided funding for this work.

References

Baxter, P. (2001). *Wool Tech. Sheep Breed.* **49:** 133–135.
Behrendt, R. (1998). PhD thesis. University of Sydney.
Behrendt, R., Newman, R., Rigby, R.D.G., Hoskinson, R.M. and Wynn, P.C. (1992). *Proc. Aust. Soc. Anim. Prod* **19:** 148.
Brown, D.J., Crook, B.J., and Purvis, I.W. (2000). *Wool Tech. Sheep Breed.* **48:** 86–93.
Brown, D.J. and Schlink, A.C. (2002). *Wool Tech. Sheep Breed.* **50:** 27–39.
Genstat Committee (2000). "GenStat for Windows. Release 4.2", 5th ed. VSN International Ltd., Oxford.
Peterson, A.D. and Gherardi, S.G. (2001). *Wool Tech. Sheep Breed.* **49:** 110–132.
Peterson, A.D., Gherardi, S.G., Ellis, M.R. (2000). *Asian-Aust. J. Anim. Sci* **13:** 180.
Verbyla, A.P., Cullis, B.R., Kenward, M.G., Welham, S.J. (1999). *Applied Statistics* **48:** 269–311.