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An evaluation of the performance of the OFDA2000 instrument operating in OFDA 100 mode

By

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SUMMARY

The OFDA2000 was designed both as a portable instrument for use on-farm, and as a laboratory instrument not only for the measurement of mean fibre diameter, diameter distribution, and fibre curvature, but also the diameter-length profiles of suitably-prepared full-length fibre specimens. Descriptions of its use for on-farm work have been published in appropriate forums. This trial was carried out to assess the performance of OFDA2000 instruments operating in OFDA 100 mode, in order to confirm that the instrument used in this manner would comply with the requirements of IWTO-47.

Data obtained in a trial of 4 OFDA 2000 instruments and 4 OFDA 100 instruments in two laboratories indicates that the OFDA2000 in 100 mode gave equivalent accuracy and precision to the OFDA100 for mean fibre diameter, for both scoured wool and tops.

On standard deviation of diameter, equivalence was also demonstrated for scoured wool using IWTO-0, but the high sensitivity of the trail allowed the results on tops to show a very small difference that was marginally statistically significant. However, the magnitude of the difference (0.02 µm), and the fact that most of the responsibility for the statistical failure of this test could be attributed to the results on the coarsest top, suggests that to all practical effect, the two models of instrument are equivalent for this parameter also.

There was a very small and consistent bias of less than 1 º/mm between the two systems on curvature. Whilst this is almost certainly of no practical importance, the precision of this difference suggests there may be an anomaly in the calibration for this parameter in the two pieces of software, and this should be investigated by the manufacturer.

The OFDA2000 in 100 mode gave higher counts than the standard instrument. However, whilst additional raw data is always notionally of benefit, there was no compelling evidence that the small percentage increase produced any statistically significant increases in precision, except perhaps on tops, where the high precision of the trial allowed a small reduction in confidence limits to be detected.

Whilst IWTO-47 does not specifically mention OFDA 100 as the model referred to, it is recommended to include a minor text change to the scope of the standard to the effect that the OFDA 2000 when specifically used in 100 mode satisfies the requirement of the standard.

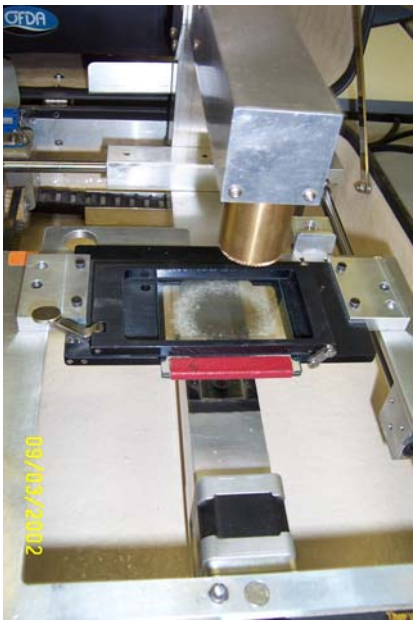
INTRODUCTION

The OFDA2000 was designed both as a portable instrument for use on-farm, and as a laboratory instrument not only for the measurement of mean fibre diameter, diameter distribution, and fibre curvature, but also the diameter-length profiles of suitably-prepared full-length fibre specimens.

Descriptions of its use for on-farm work have been published in appropriate forums. (Brims et al 1999, Baxter 2001, Peterson & Gherardi 2001).

The instrument is capable of being used in a laboratory in "OFDA 100 mode" to measure snippets spread over a 70 mm glass slide, since it uses the same fibre-recognition and measurement algorithms as the OFDA 100 (Baxter et al 1992). In this mode it fully emulates the instrument described in IWTO-47, with the added advantage that the average measurement time for a slide is at least halved by using the speed advantages of Windows 32 bit processing and the benefits of the improved PCI bus over the ISA bus used in the DOS-based OFDA 100. Where the instrument will only be used in a laboratory, a bench-top version is available (without the carrying case).

When used in OFDA 100 mode (which is selected in the software menu), a special carriage is mounted on the slide carrier. The carriage accepts the standard 70mm square glass slides used by the OFDA100, as can be seen in the photographs below:



The work described in this paper was undertaken to establish whether the OFDA2000 operating in OFDA 100 mode gave equivalent results to a standard OFDA 100 instrument.

EXPERIMENTAL METHOD

The trial was designed to:

- as far as possible, minimise all sources of variance other than measurement
- test measurement of both sliver and scoured wool specimens
- test equivalence of both accuracy and precision
- ensure that the participants were unable to identify replicates

Raw wool core samples were selected to cover a range of wool types. In the 25 samples selected, woolbase ranged from 48 to 70%, vegetable matter base from 0 to 4.3%, and mean fibre diameter from 16 to 42 µm. The core samples were well-blended and then scoured and dried as 150g sub-samples in the normal manner. The scoured and dried core samples were then split into 10 to 15g specimens by representative sampling. Two sets of replicates were selected at random from each sample, and identified in a manner that precluded any obvious matching of sub-sample pairs. Each laboratory was therefore supplied with what appeared to be 50 separate scoured and dried subsamples.

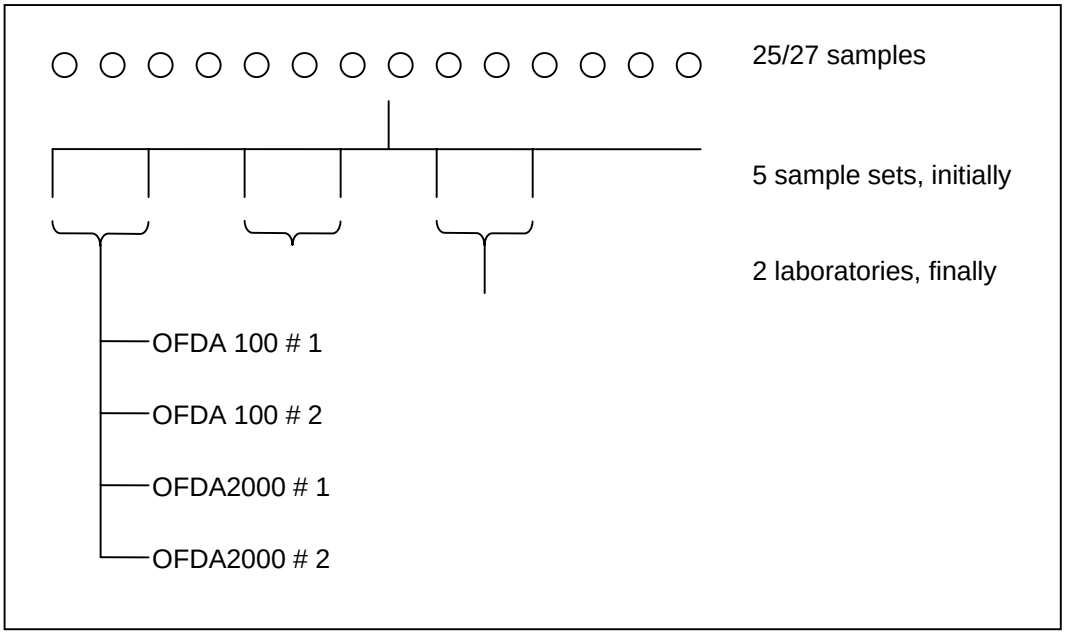
A total of 27 top samples were selected from a wide variety of sources, including a dark-coloured wool. The tops covered the diameter range from 17 to 36 µm. 20 cm lengths were cut from each top sample

and sets of blind replicates were prepared so that each laboratory received what appeared to be 54 separate samples.

The instructions to participants are shown in Appendix 1. As indicated above, since we were only interested in comparing instruments, rather than test methods, as many sources of variance as possible were minimised by these procedures.

Initially it was intended that 4 separate laboratories would participate, each with one OFDA 100 and one OFDA2000. Unfortunately, due to the Australian Quarantine Service initially impounding and then losing the sample sets sent to Australia, the final delayed trial could only be undertaken in 2 laboratories (MicronMan Pty Ltd, and SGS Wool Testing Services), but with 2 OFDA 100 and 2 OFDA 2000 instruments in each. Since the aim of the work was to compare instruments, rather than preparation techniques or laboratories, this was adequate. The final trial therefore included 4 OFDA 100 instruments and 4 OFDA 2000 instruments, all of which had to be calibrated for both scoured wool and tops.

A schematic of the trial design is shown below:



Each subsample was measured using two separate slides, and therefore the total workload included 16 calibrations and validations and over 1600 individual measurements. Each laboratory reported MFD, SD, count and mean curvature on all measurements. No observations were eliminated as outliers and there was only 1 missing value.

ANALYTICAL METHODS

All analyses were performed in accordance with IWTO-0 Appendix B. Accuracy was compared using the grand means from the two instrument models. Precision was compared by carrying out one way analyses of variance on the results from every sample to establish the two principle components of variance: between instruments (in each model), and within instruments (the error variance, which included a between-sub-sample component as well as the actual measurement variance). It was not considered worthwhile to isolate the components of the error variance, since the total represents the typical measurement process in normal usage.

The analysis of variance schema for each sample in each instrument class is shown overleaf:

Source	dF	Mean squares	Expected MS
Between instruments (in model)	3	A	$\sigma^2 + 4\,\sigma^2_I$
Error (measurement + b'ween subs)	12	B	σ^2

Where σ^2_I represents the component of variance due to between-instruments.

95% confidence limits were then calculated for the purposes of this trial as follows:

$$95\%CL = 1.96 * \text{sqrt}\ (\sigma^2_I + \sigma^2/4)$$

It should be noted that whilst these 95% confidence limits were calculated in the normal manner, this trial only included 2 laboratories, and the between-instrument variance was artificially reduced (by performing calibrations and measurements in each laboratory using the same slides) in order to increase the precision of the comparisons. The sole purpose of these confidence limit calculations is to allow direct comparison of the instrument performance using the normal parameters, but with minimal interference from other factors.

RESULTS

Appendices 2 and 3 show the geometric mean and difference versus average plots for each parameter for scoured wool and tops, together with paired data plots on individual slides for information.

The summary statistics required by IWTO-0 are tabulated below:

SUMMARY - SCOURED WOOL (25 OBSERVATIONS)

Means and average differences:

Instrument class	**100**	**2000**	**100**	**2000**	**100**	**2000**	**100**	**2000**
Parameter	**mfd**		**sd**		**count**		**curve**	
Mean	29.35	29.33	7.88	7.91	3326	3607	69.98	69.04
Standard deviation	7.71	7.71	2.43	2.43	907	993	19.40	19.48

Difference/average	**Diff**	**Avg**	**Diff**	**Avg**	**Diff**	**Avg**	**Diff**	**Avg**
Parameter	**mfd**		**sd**		**count**		**curve**	
Mean	-0.01	29.34	0.03	7.90	281	3466	-0.94	69.51
Standard deviation	0.07	7.71	0.08	2.43	136	949	0.70	19.44
Standard error	0.014	1.54	0.016	0.49	27	190	0.14	3.89
t value	0.976		1.857		10.32		6.68	
p value	0.339		0.076		0.000		0.000	
Significance	ns		ns		***		***	

(Differences are all calculated as OFDA2000 minus OFDA 100)

The results in this table show no systematic bias for mean fibre diameter or standard deviation of diameter between the two models of instrument when measuring scoured wool. The OFDA2000 in 100 mode gave systematically higher counts on each slide, and an average curvature lower by approximately 1 º/mm.

Regression statistics:

Regression type:	**GM**	**DVA**	**GM**	**DVA**	**GM**	**DVA**	**GM**	**DVA**
Parameter	**mfd**		**sd**		**count**		**curve**	
Estimated slope	1.000	0.000	1.001	0.001	1.046	0.091	1.002	0.004
SE of slope	0.002	0.002	0.002	0.007	0.002	0.023	0.002	0.008
t value of slope	0.028	0.065	0.332	0.193	21.2	3.892	1.062	0.594
Significance of slope (from 1.0)	ns	ns	ns	ns	***	***	ns	ns
R-value of correlation	*0.9999*	*0.014*	*0.9999*	*0.040*	*0.9999*	*0.630*	*0.9999*	*0.123*
t value	*479.6*	*0.065*	*479.6*	*0.193*	*479.6*	*3.892*	*479.6*	*0.594*
Significance of correlation	***	*ns*	***	*ns*	***	***	***	*ns*

These statistics confirm that for scoured wool there was no slope bias between the two models of instrument for mean fibre diameter, standard deviation of diameter or mean curvature. There was a statistically significant positive slope on the counts relationship, indicating that the OFDA2000 in 100 mode measured progressively more counts as the number of counts increased.

Reviewing the plots shown in Appendix 2, it can be seen that in some cases, at the lower count levels, the two models of instrument appeared to record similar counts. However, it should be noted that whereas the OFDA 100 software requires the slide to be re-measured until the total count reaches the preset level of at least 2000, this particular option was not available in the software for the OFDA2000 at the time this work was carried out. In consequence, on some slides, the OFDA 100 may have measured a slide twice, whilst the OFDA2000 measured all slides only once.

SUMMARY - TOPS (27 OBSERVATIONS)

Means and average differences:

Instrument class	**100**	**2000**	**100**	**2000**	**100**	**2000**	**100**	**2000**
Parameter	**mfd**		**sd**		**count**		**curve**	
Mean	24.19	24.19	5.64	5.65	3967	4378	62.06	61.42
Standard deviation	4.41	4.41	1.32	1.33	770	870	13.58	13.54

Difference/average	**Diff**	**Avg**	**Diff**	**Avg**	**Diff**	**Avg**	**Diff**	**Avg**
Parameter	**mfd**		**sd**		**count**		**curve**	
Mean	0.00	24.19	0.02	5.65	411	4378	-0.64	61.42
Standard deviation	0.03	4.41	0.04	1.33	130	870	0.52	13.54
Standard error	0.006	0.85	0.007	0.26	25.0	167	0.10	2.61
t value	0.128		2.328		16.40		6.423	
p value	0.899		0.028		0.000		0.000	
Significance	ns		*		***		***	

The results in this table show no systematic bias for mean fibre diameter between the two models of instrument when measuring tops. The OFDA2000 in 100 mode gave a marginally higher SD and substantially more counts on each slide, and an average curvature lower by approximately 0.6 º/mm.

Regression statistics:

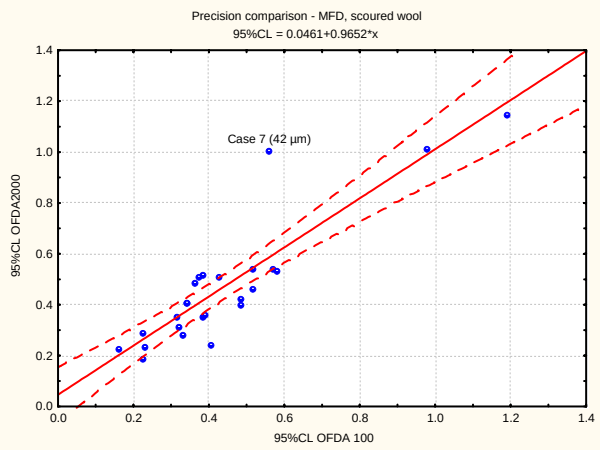
Regression type:	**GM**	**DVA**	**GM**	**DVA**	**GM**	**DVA**	**GM**	**DVA**
Parameter	**mfd**		**sd**		**count**		**curve**	
Estimated slope	1.000	0.000	1.005	0.011	1.063	0.123	0.999	-0.002
SE of slope	0.002	0.001	0.005	0.005	0.021	0.020	0.008	0.008
t value of slope	0.077	0.212	1.096	2.222	2.97	6.15	0.146	0.294
Significance of slope (from 1.0)	ns	ns	ns	*	**	***	ns	ns
R-value of correlation	*0.999*	*0.042*	*0.9997*	*0.406*	*0.9949*	*0.776*	*0.9992*	*0.059*
t value	*500.0*	*0.834*	*204.1*	*2.222*	*49.5*	*6.15*	*129.0*	*0.294*
Significance of correlation	***	*ns*	***	*	***	***	***	*ns*

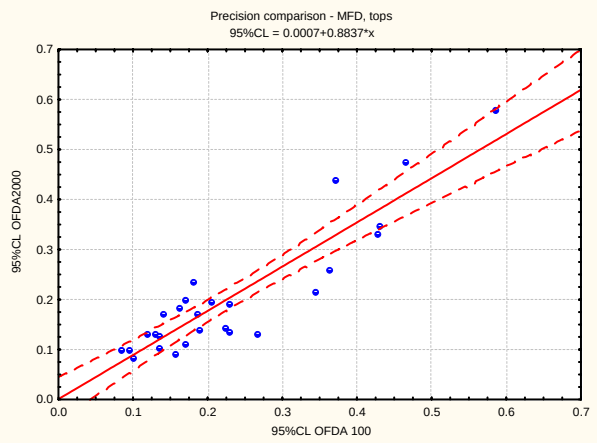
These statistics confirm that for tops there was no slope bias between the two models of instrument for mean fibre diameter or mean curvature. There was a statistically significant positive slope on the counts relationship, indicating that the OFDA2000 in 100 mode measured progressively more counts as the number of counts increased. There was a marginal slope bias on the standard deviation of diameter, which was not significant in the GM analysis and only marginally significant in the DVA analysis. Examination of the plots in Appendix 3 indicate that this was most probably due to a small difference on the broadest top, which leveraged the DVA regression.

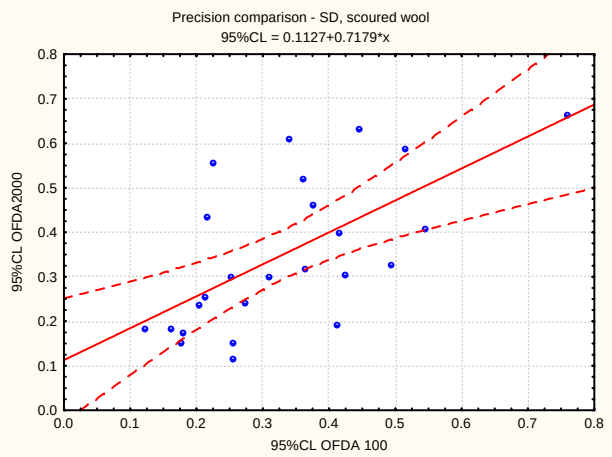
PRECISION ESTIMATE COMPARISONS

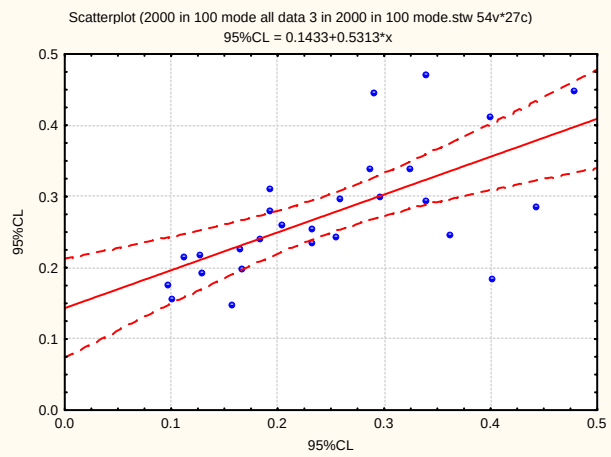
Appendix 4 details the results of the analyses of variance for the scoured wool and top samples.

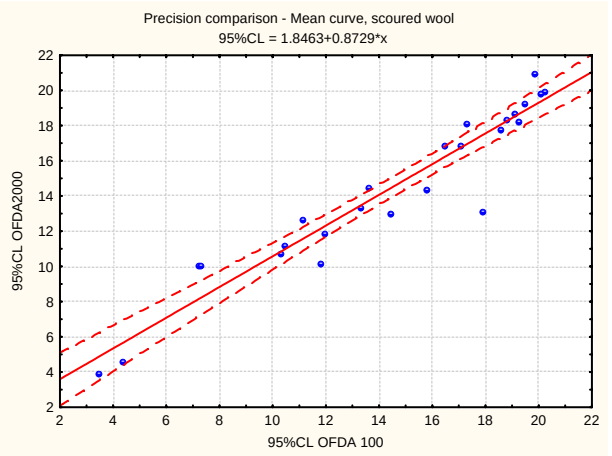
IWTO-0 contains no guidelines on the assessment of the equivalence of precision. For information, graphical comparisons follow, using the calculated 95% confidence limits:

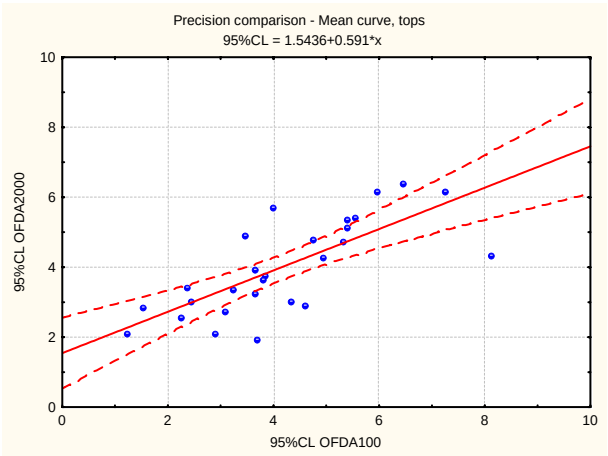












In the plots, the dotted lines represent the 95% confidence limits on the regression line. It is clear that for mean fibre diameter, the two models of instrument showed similar levels of precision. The precision of standard deviation was somewhat more scattered. There was a significant discrepancy in the precision of curve for scoured wool as compared with tops. By reference to Appendix 4, it can be seen that this is largely the result of significant between-instrument variances. However, examination of the raw data shows that the real cause is a bias of some 10 to 15 º/mm between the two laboratories on their scoured wool curvature values. Since there was no processing required at the laboratories, other than re-drying, conditioning and minicoring, the most obvious candidate for the cause of the difference is the different minicores in use at the two laboratories.

To examine the precision estimates objectively, paired differences and geometric mean analyses were carried out on the estimated 95% confidence limits. In view of the unambiguous outcome from these analyses, it was unnecessary to carry out DVA analyses.

SUMMARY - PRECISION ESTIMATES FOR SCOURED WOOL (25 OBSERVATIONS)

Means and average differences of 95% confidence limits:

Instrument class	**100**	**2000**	**100**	**2000**	**100**	**2000**
Parameter	**mfd**		**sd**		**curve**	
Mean 95% CL	0.44	0.47	0.33	0.35	14.3	14.4
Standard deviation of CL	0.23	0.25	0.15	0.17	5.1	4.6

Difference/average	**Diff**	**Avg**	**Diff**	**Avg**	**Diff**	**Avg**
Parameter	**mfd**		**sd**		**curve**	
Mean 95% CL	0.03	0.46	0.02	0.34	0.02	14.4
Standard deviation	0.11	0.23	0.14	0.16	1.49	4.8
Standard error	0.02	0.05	0.03	0.03	0.30	0.96
t value	1.342		0.706		0.082	
p value	0.192		0.487		0.936	
Significance	ns		ns		ns	

(Differences are all calculated as OFDA2000 minus OFDA 100)

The results in this table show no systematic bias for the estimates of precision of mean fibre diameter, standard deviation or mean curve between the two models of instrument when measuring scoured wool.

Geometric mean regression statistics on 95% confidence limits:

Parameter	**mfd**	**sd**	**curve**
Estimated slope	1.090	1.146	0.912
SE of slope	0.106	0.393	0.055
t value of slope	0.853	0.783	1.603
Significance of slope (from 1.0)	ns	ns	ns
R-value of correlation	*0.8854*	*0.6265*	*0.9573*
t value	*9.13*	*3.855*	*15.9*
Significance of correlation	***	***	***

These statistics confirm that for scoured wool there was no statistically significant slope bias between the precision estimates for the two models of instrument for mean fibre diameter, standard deviation of diameter or mean curvature.

SUMMARY - PRECISION ESTIMATES FOR TOPS (27 OBSERVATIONS)

Means and average differences of 95% confidence limits:

Instrument class	**100**	**2000**	**100**	**2000**	**100**	**2000**
Parameter	**mfd**		**sd**		**curve**	
Mean 95% CL	0.23	0.21	0.25	0.28	4.2	4.0
Standard deviation of CL	0.13	0.13	0.11	0.09	1.7	1.3

Difference/average	**Diff**	**Avg**	**Diff**	**Avg**	**Diff**	**Avg**
Parameter	**mfd**		**sd**		**curve**	
Mean 95% CL	-0.03	0.22	0.03	0.26	-0.22	4.2
Standard deviation	0.06	0.13	0.09	0.10	1.2	1.5
Standard error	0.01	0.03	0.02	0.02	0.2	0.3
t value	2.44		1.60		0.94	
p value	0.022		0.122		0.36	
Significance	*		ns		ns	

(Differences are all calculated as OFDA2000 minus OFDA 100)

The results in this table show no systematic bias for the estimates of precision of standard deviation or mean curve between the two models of instrument when measuring tops, and marginal evidence of improved precision on mean fibre diameter for the OFDA2000 in 100 mode.

Geometric mean regression statistics on 95% confidence limits:

Parameter	**mfd**	**sd**	**curve**
Estimated slope	0.973	0.818	0.806
SE of slope	0.081	0.124	0.110
t value of slope	0.335	1.462	1.775
Significance of slope (from 1.0)	ns	ns	ns
R-value of correlation	*0.9084*	*0.6495*	*0.7336*
t value	*10.4*	*4.09*	*5.18*
Significance of correlation	***	***	***

These statistics indicate that for tops there was no statistically significant slope bias between the precision estimates for the two models of instrument for mean fibre diameter, standard deviation of diameter or mean curvature.

DISCUSSION & CONCLUSIONS

These data indicate that the OFDA2000 in 100 mode gave equivalent accuracy and precision to the OFDA100 for mean fibre diameter, for both scoured wool and tops.

On standard deviation of diameter, equivalence was also demonstrated for scoured wool, but due to the high sensitivity of the trial, the results on tops showed a very small difference that was marginally statistically significant. However, the magnitude of the difference (0.02 µm), and the fact that most of the responsibility for the statistical failure of this test could be attributed to the results on the coarsest top, suggests that to all practical effect, the two models of instrument are equivalent for this parameter also.

There was a very small and consistent bias of less than 1 º/mm between the two systems on curvature. Whilst this is almost certainly of no practical importance, the precision of this differences suggests there may be an anomaly in the calibration for this parameter in the two pieces of software, and this should be investigated by the manufacturer.

The OFDA2000 in 100 mode gave higher counts than the standard instrument. The manufacturer indicates that this is due to the higher speed of the 32 bit Windows system and the PCI bus used in the OFDA2000. However, whilst additional raw data is always notionally of benefit, there was no compelling evidence that the small percentage increase produced any statistically significant increases in precision, except perhaps on tops, where the high precision of the trial allowed a small reduction in confidence limits to be detected.

Whilst IWTO-47 does not specifically mention OFDA 100 as the model referred to, it is recommended to include a text change in the scope of the Standard to the effect that the OFDA 2000 when specifically used in 100 mode satisfies the requirement of the standard. Appendix 5 shows the recommended change.

REFERENCES

IWTO-0-01: Procedures for the development, review, progression or relegation of IWTO test methods and draft test methods. Appendix B: Presentation of supporting technical data.

IWTO-47-00: Measurement of the mean and distribution of fibre diameter of wool using an Optical Fibre Diameter Analyser (OFDA)

Baxter, B. P., Brims, M. A. and Taylor, T. (1992) *Description and performance of the Optical Fibre Diameter Analyser (OFDA)*. Journal of the Textile Institute, **83** (8), 507-526

Baxter, B. P. (2001) *On-farm classing of animals & fleeces with the OFDA2000*. Wool Technology and Sheep Breeding, **49** (2), 133-155

Brims, M. A., Peterson, A. D. and Gherardi, S. G. (1999) *Introducing the OFDA2000 - For rapid measurement of diameter profile on greasy wool staples*. IWTO, Florence, Italy, Raw wool group report RWG04

Peterson, A. D. and Gherardi, S. G. (2001) *The ability of the OFDA2000 to measure fleeces and sale lots on-farm*. Wool Technology and Sheep Breeding, **49** (2), 110-132

APPENDIX 1

OFDA2000 operating in 100 mode - Equivalence round trial

Instructions to participants

Participants must have access to and experience with both OFDA100 and OFDA2000 instruments. The latter must be fitted with a 70mm slide carrier. Participants require both a 2mm OFDA guillotine and a 2mm minicore.

The same spreader must be used for both calibration and measurement. Both instruments must be set to measure fibres from 4 to 160 µm for both calibration and measurement.

The two instruments should be operated side by side to avoid potential changes in the slides between one instrument and the other. (The same slides will be measured on both instruments.)

The work must be carried out in the standard atmosphere of 20 ºC and 65% relative humidity.

The calibration and measurement on the OFDA2000 shall be carried out with the following settings:

- Grease correction factor None
- RH correct None
- Trim high No

Curve measurement must be enabled on both instruments.

The sample bags carry a single digit hand-written number - this is to be used as the laboratory identification.

All samples should be dried at 70 ºC for 30 minutes in a ventilated oven or forced air dryer and then immediately brought into the standard atmosphere to condition for at least 24 hours.

Samples are provided of each of the current IH series tops, both as sliver, and as scoured material. Participants **must** calibrate both instruments **together** using the same specimens (slides) immediately prior to commencing this trial. Two separate calibrations are required for each instrument, one for sliver and the other for scoured wool measurements. The calibrations must all comply with IWTO-47 and should be validated with the calibration material.

Once the instruments are satisfactorily calibrated, measurements may proceed. Two sets of samples are provided - one comprises 54 sliver samples and the other 50 scoured wool samples. Both sets contain blind replicates.

The sliver samples are to be sampled using the guillotine and measured on the sliver calibration. The scoured samples are to be minicored and measured on the scoured wool calibration.

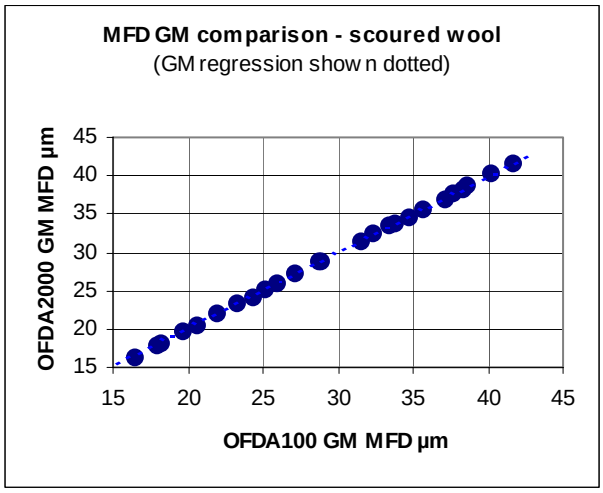
Two slides are to be prepared from every sample and both are to be measured on both instruments. It is important that the results on each instrument for every slide carry the correct identification that can be matched to the measurement on the other instrument of the same slide

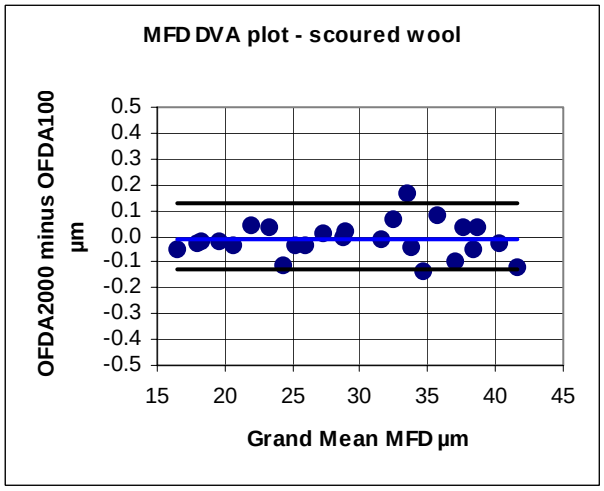
Each slide is to be measured on "wholeslide x 1" on both instruments. The order in which the slides are presented to the instruments (i.e. OFDA100 before OFDA2000 or vice versa) should, where practicable, be alternated or randomised so that one instrument is not always measuring a slide that could have been disturbed during transfer from the first to the second instrument.

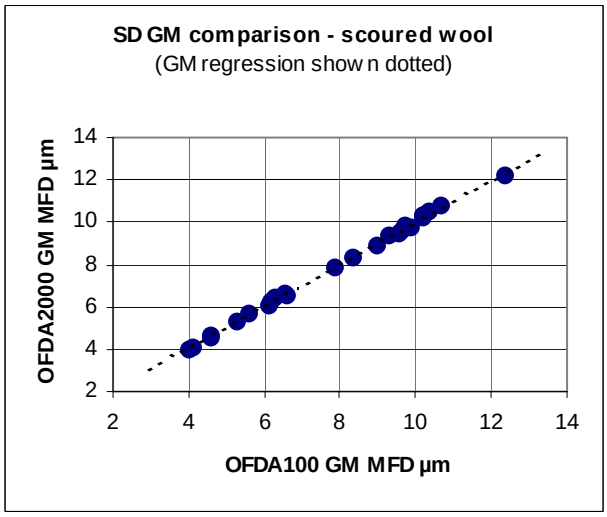
All measurements, including calibration, should be saved in MES files, which should be emailed to the analyst.

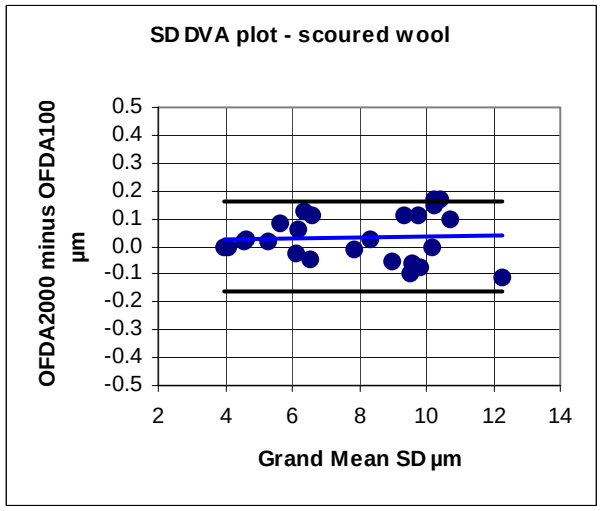
APPENDIX 2

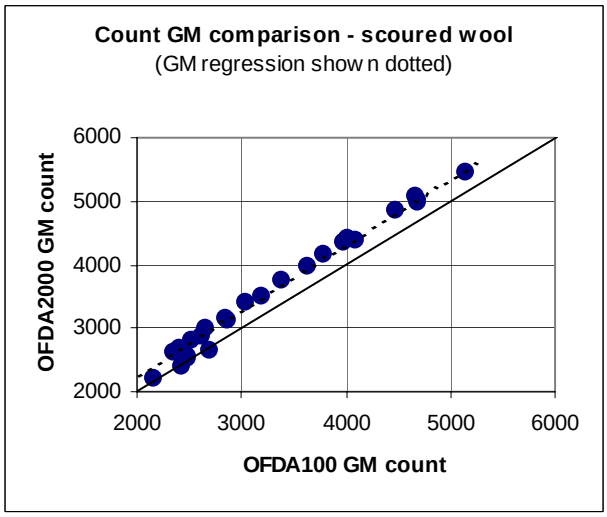
Geometric mean and DVA plots for scoured wool samples

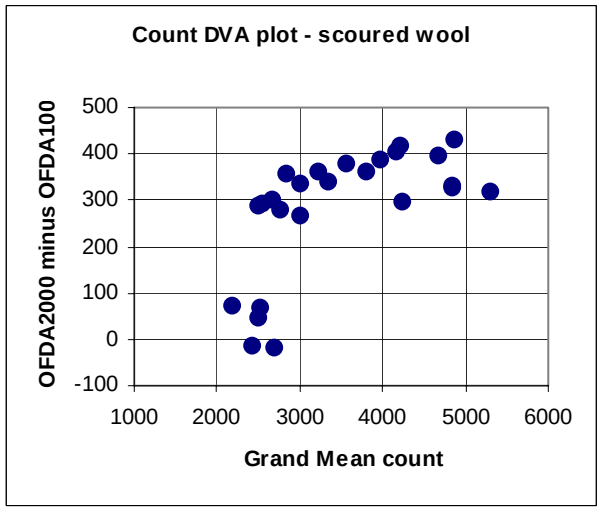


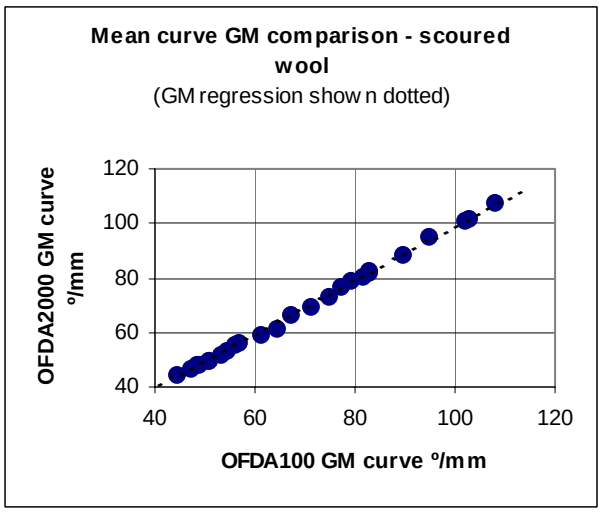


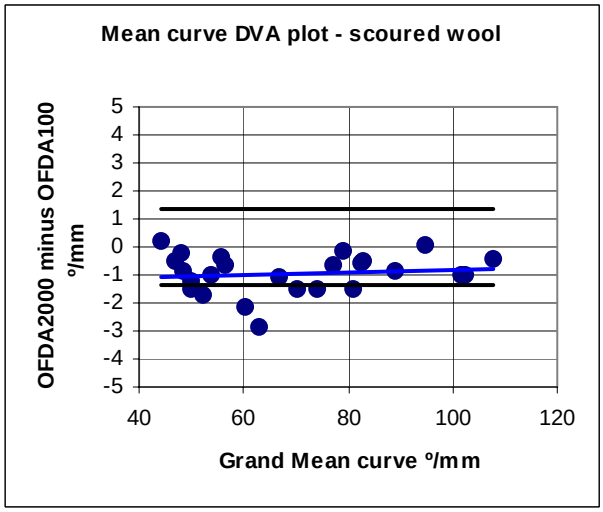


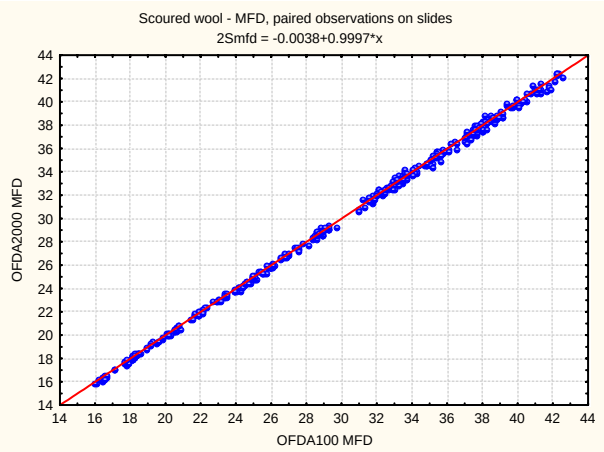


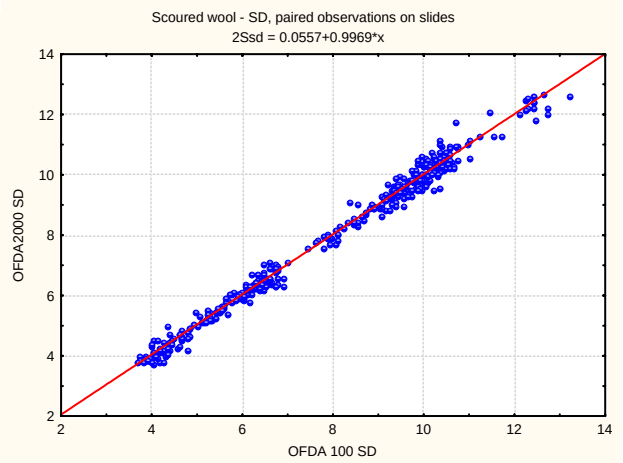


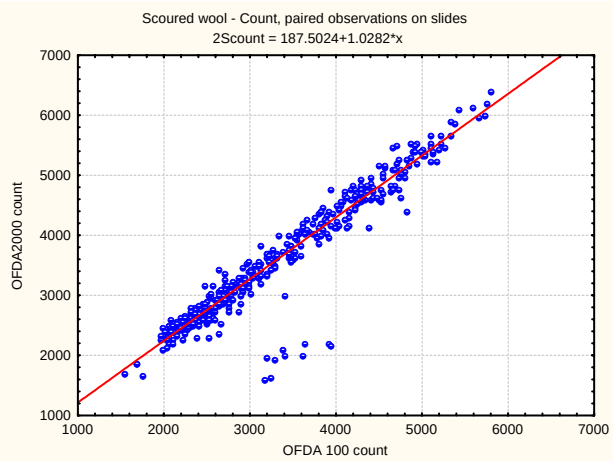


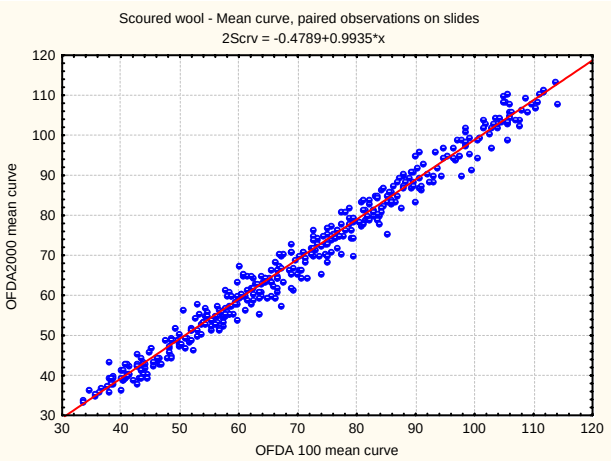

Mean curve GM comparison - scoured wool
(GM regression shown dotted)
OFDA2000 GM curve °/mm
OFDA100 GM curve °/mm
120
100
80
60
40
40
60
80
100
120


Mean curve DVA plot - scoured wool
OFDA2000 minus OFDA100 °/mm
Grand Mean curve °/mm
5
4
3
2
1
0
-1
-2
-3
-4
-5
40
60
80
100
120


Scoured wool - MFD, paired observations on slides
2Smfd = -0.0038+0.9997*x
OFDA2000 MFD
OFDA100 MFD
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44

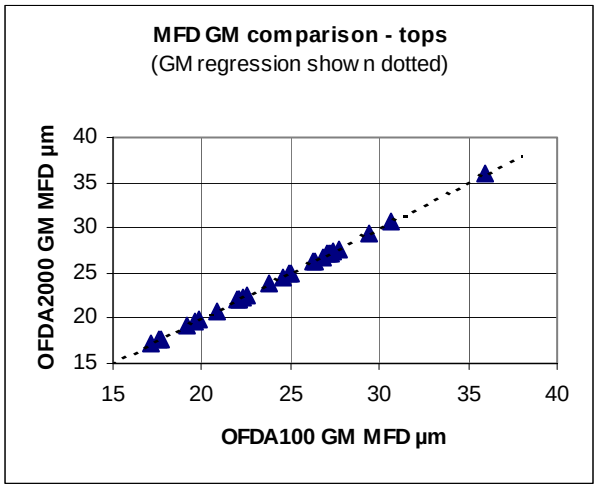

Scoured wool - SD, paired observations on slides
2Ssd = 0.0557+0.9969*x
OFDA2000 SD
OFDA 100 SD
14
12
10
8
6
4
2
2
4
6
8
10
12
14

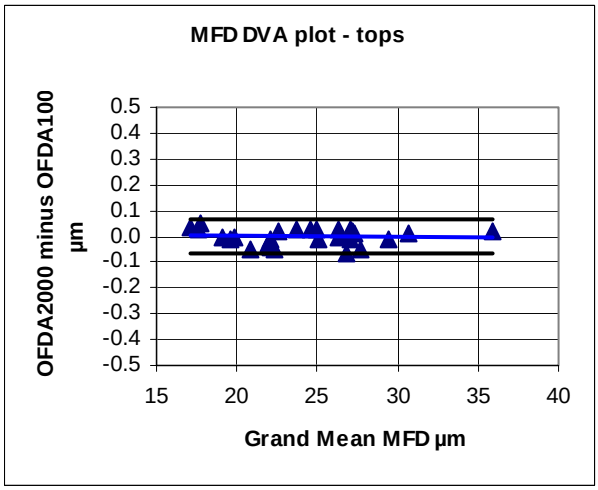

Scoured wool - Count, paired observations on slides
2Scount = 187.5024+1.0282*x
OFDA2000 count
OFDA 100 count
7000
6000
5000
4000
3000
2000
1000
1000
2000
3000
4000
5000
6000
7000

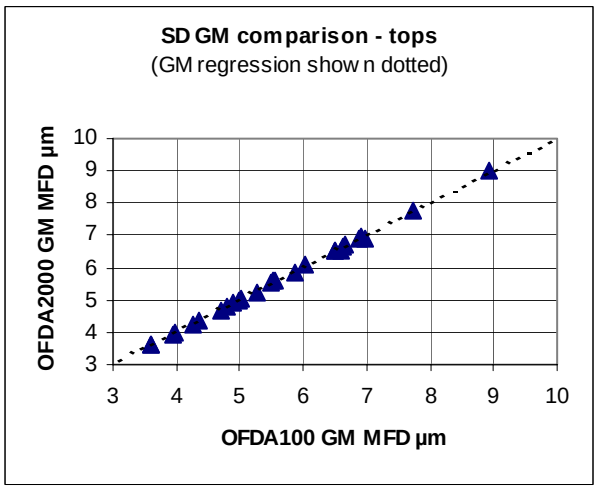

Scoured wool - Mean curve, paired observations on slides
2Scrv = -0.4789+0.9935*x
OFDA2000 mean curve
OFDA 100 mean curve
120
110
100
90
80
70
60
50
40
30
30
40
50
60
70
80
90
100
110
120

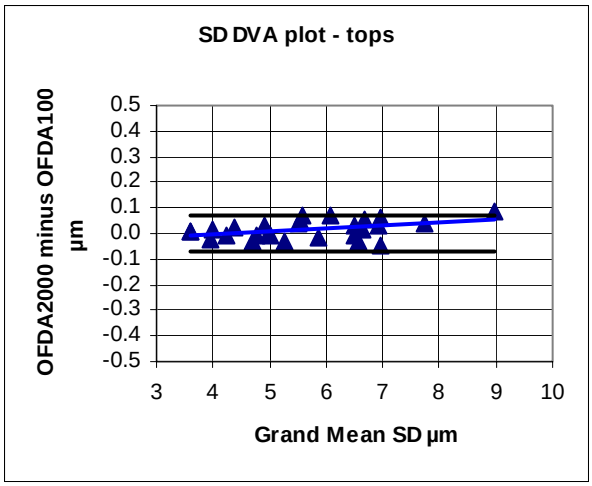
APPENDIX 3

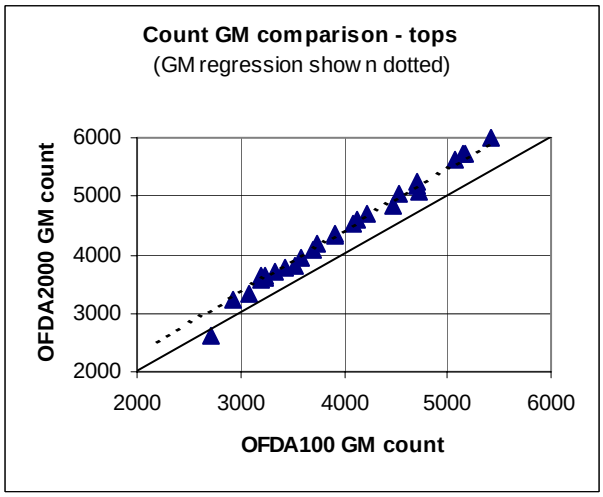
Geometric mean and DVA plots for scoured wool samples

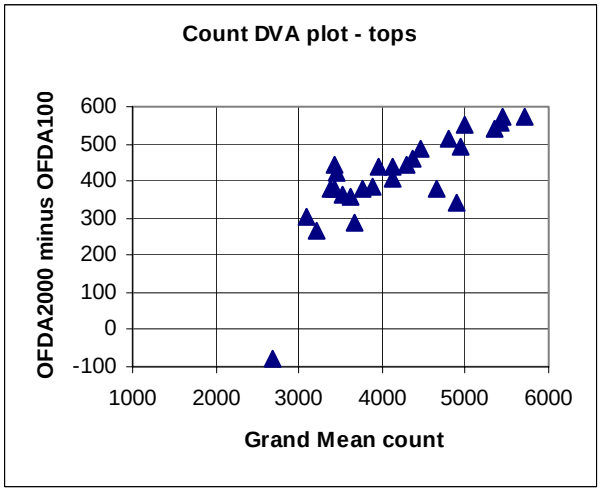


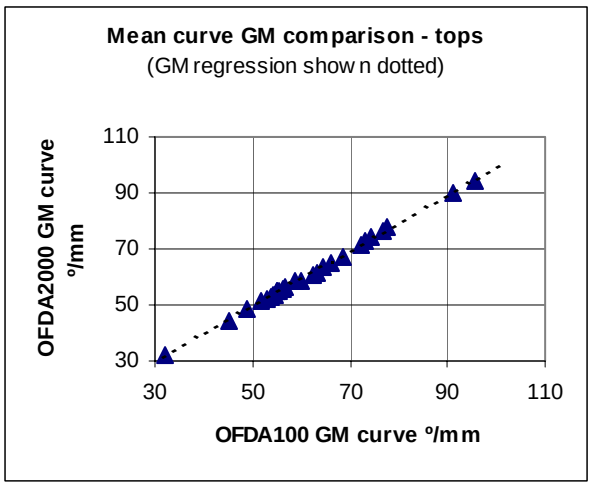


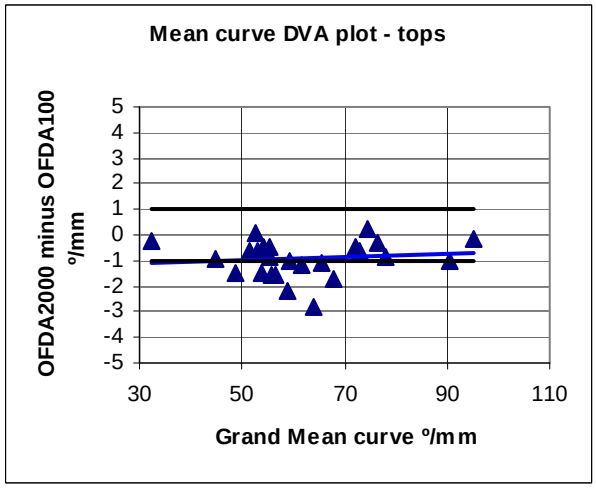


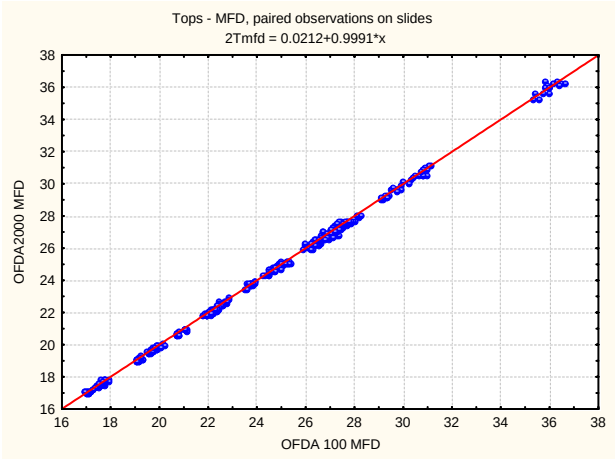


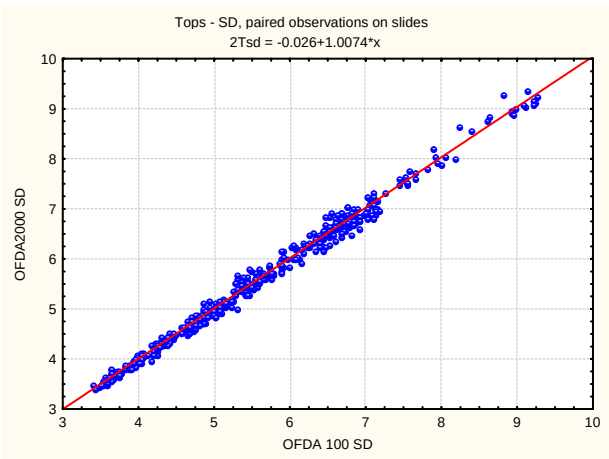


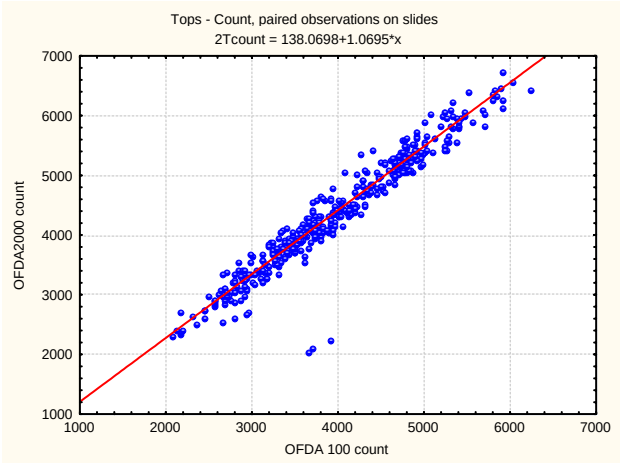


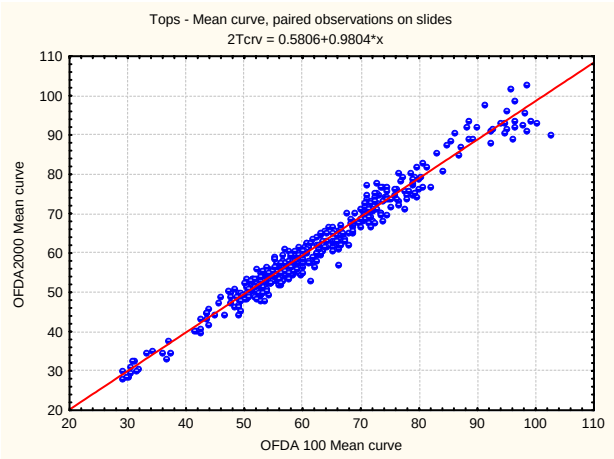

Mean curve GM comparison - tops
(GM regression shown dotted)
OFDA2000 GM curve °/mm
OFDA100 GM curve °/mm
30
50
70
90
110


Mean curve DVA plot - tops
OFDA2000 minus OFDA100 °/mm
Grand Mean curve °/mm
-5
-4
-3
-2
-1
0
1
2
3
4
5
30
50
70
90
110


Tops - MFD, paired observations on slides
2Tmfd = 0.0212+0.9991*x
OFDA2000 MFD
OFDA 100 MFD


Tops - SD, paired observations on slides
2Tsd = -0.026+1.0074*x
OFDA2000 SD
OFDA 100 SD


Tops - Count, paired observations on slides
2Tcount = 138.0698+1.0695*x
OFDA2000 count
OFDA 100 count


Tops - Mean curve, paired observations on slides
2Tcrv = 0.5806+0.9804*x
OFDA2000 Mean curve
OFDA 100 Mean curve

APPENDIX 4

Summary of analyses of variance - Scoured wool

	MFD	OFDA2000			OFDA 100			IWTO	SD	OFDA2000			OFDA 100			IWTO	Curve	OFDA2000			OFDA 100		
sample	GM	BI	error	95%CL	BI	error	95%CL	-47	GM	BI	error	95%CL	BI	error	95%CL	-47	GM	BI	error	95%CL	BI	error	95%CL
1	24.3	0.05	0.06	0.51	0.04	0.04	0.43	0.45	6.57	0.00	0.10	0.31	0.04	0.03	0.42	0.34	80.8	35.11	6.56	11.88	34.93	7.58	11.89
2	35.6	0.00	0.04	0.19	0.00	0.05	0.22	0.68	10.45	0.08	0.06	0.61	0.02	0.04	0.34	0.41	48.1	84.72	6.73	18.22	95.38	4.53	19.25
3	21.9	0.00	0.06	0.24	0.00	0.05	0.23	0.40	5.66	0.07	0.02	0.52	0.03	0.02	0.36	0.32	82.4	38.53	14.77	12.74	29.51	10.48	11.11
4	23.3	0.00	0.13	0.36	0.00	0.15	0.38	0.42	6.20	0.00	0.02	0.15	0.00	0.07	0.25	0.33	82.7	26.07	3.65	10.18	33.55	9.27	11.74
5	28.7	0.00	0.10	0.31	0.00	0.10	0.32	0.54	8.36	0.00	0.09	0.30	0.00	0.10	0.31	0.37	70.3	42.84	5.32	13.03	52.90	3.80	14.38
6	18.0	0.06	0.05	0.51	0.02	0.06	0.37	0.31	4.61	0.00	0.22	0.46	0.00	0.15	0.37	0.30	102.3	0.00	21.74	4.57	0.00	19.36	4.31
7	41.6	0.21	0.21	1.01	0.01	0.28	0.56	0.81	12.29	0.02	0.11	0.41	0.04	0.15	0.54	0.45	50.0	86.49	4.54	18.35	90.35	4.63	18.75
8	37.1	0.00	0.31	0.54	0.00	0.34	0.57	0.72	10.26	0.09	0.04	0.63	0.04	0.04	0.44	0.41	48.3	95.70	6.41	19.33	96.90	7.31	19.47
9	20.6	0.00	0.14	0.36	0.00	0.16	0.39	0.37	5.30	0.00	0.02	0.15	0.00	0.03	0.18	0.31	94.7	30.58	7.68	11.17	24.30	16.32	10.44
10	40.2	0.02	0.23	0.54	0.03	0.22	0.58	0.78	10.73	0.07	0.17	0.67	0.13	0.09	0.76	0.41	44.3	103.50	3.12	20.02	105.55	2.99	20.21
11	37.6	0.00	0.09	0.29	0.00	0.05	0.22	0.73	9.77	0.06	0.08	0.56	0.00	0.05	0.22	0.40	47.0	71.18	13.07	16.91	72.96	10.89	17.05
12	16.4	0.02	0.10	0.41	0.01	0.09	0.34	0.28	4.10	0.00	0.09	0.30	0.00	0.06	0.25	0.29	107.8	1.76	8.66	3.88	0.00	12.09	3.41
13	18.2	0.01	0.02	0.23	0.00	0.02	0.16	0.32	3.99	0.00	0.04	0.18	0.00	0.02	0.12	0.29	101.5	24.38	8.23	10.08	12.90	2.49	7.21
14	38.7	0.00	0.22	0.46	0.00	0.28	0.52	0.75	10.20	0.01	0.06	0.33	0.06	0.03	0.49	0.41	50.1	88.22	11.35	18.70	91.11	13.97	19.06
15	33.8	0.32	0.11	1.15	0.33	0.15	1.19	0.65	9.56	0.00	0.04	0.19	0.03	0.06	0.41	0.39	66.7	45.68	3.95	13.39	44.26	7.47	13.31
16	38.4	0.16	0.42	1.01	0.19	0.25	0.98	0.74	10.25	0.00	0.09	0.32	0.02	0.04	0.36	0.41	52.3	81.03	5.94	17.80	88.03	7.03	18.57
17	19.6	0.00	0.19	0.43	0.00	0.24	0.48	0.35	4.57	0.00	0.07	0.26	0.00	0.05	0.21	0.30	89.0	24.38	7.61	10.05	10.44	12.68	7.23
18	25.2	0.00	0.05	0.24	0.03	0.05	0.40	0.46	6.12	0.04	0.00	0.40	0.04	0.01	0.41	0.33	79.2	29.18	4.55	10.79	26.45	4.29	10.28
19	34.7	0.00	0.31	0.54	0.00	0.28	0.52	0.67	9.51	0.08	0.03	0.59	0.06	0.04	0.51	0.39	55.7	84.49	4.71	18.14	75.81	5.97	17.23
20	27.2	0.00	0.17	0.40	0.01	0.19	0.48	0.51	6.61	0.00	0.06	0.24	0.00	0.04	0.20	0.34	77.1	52.57	8.87	14.51	46.04	8.01	13.59
21	26.0	0.00	0.13	0.35	0.00	0.10	0.31	0.48	6.37	0.03	0.09	0.44	0.00	0.03	0.21	0.33	74.0	44.10	4.51	13.18	82.38	2.29	17.85
22	31.6	0.03	0.15	0.52	0.00	0.14	0.38	0.60	9.35	0.00	0.04	0.19	0.00	0.01	0.16	0.39	62.9	53.35	2.06	14.38	63.68	3.40	15.75
23	28.9	0.05	0.03	0.49	0.01	0.09	0.36	0.54	7.86	0.00	0.02	0.18	0.00	0.03	0.18	0.36	60.2	100.34	9.43	19.86	102.24	9.10	20.04
24	32.4	0.00	0.08	0.28	0.00	0.11	0.33	0.62	8.96	0.00	0.01	0.12	0.00	0.07	0.25	0.38	53.8	112.75	7.06	20.97	99.64	10.96	19.83
25	33.5	0.00	0.17	0.41	0.00	0.12	0.34	0.64	9.83	0.00	0.06	0.24	0.00	0.08	0.27	0.40	56.5	73.12	4.93	16.90	68.55	7.88	16.46
Average	29.3	0.04	0.14	0.47	0.03	0.15	0.44	0.55	7.9	0.02	0.07	0.35	0.02	0.05	0.33	0.36	69.5	57.2	7.4	14.4	57.9	8.2	14.3

Summary of analyses of variance - Tops

	MFD	OFDA2000			OFDA 100			IWTO	SD	OFDA2000			OFDA 100			IWTO	Curve	OFDA2000			OFDA 100		
Top	GM	BI	error	95%CL	BI	error	95%CL	-47	GM	BI	error	95%CL	BI	error	95%CL	-47	GM	BI	error	95%CL	BI	error	95%CL
1	27.0	0.05	0.02	0.44	0.02	0.05	0.37	0.48	6.5	0.06	0.01	0.47	0.03	0.01	0.34	0.34	53.9	0.67	1.17	1.92	3.11	1.65	3.68
2	35.9	0.07	0.07	0.58	0.07	0.08	0.58	0.69	9.0	0.01	0.04	0.29	0.03	0.07	0.44	0.40	32.2	3.55	5.02	4.29	5.26	4.16	4.92
3	25.1	0.00	0.01	0.14	0.01	0.03	0.23	0.43	5.5	0.02	0.01	0.30	0.02	0.01	0.29	0.32	51.5	1.75	2.69	3.05	3.96	3.73	4.34
4	27.2	0.00	0.04	0.19	0.00	0.05	0.23	0.48	6.9	0.02	0.02	0.30	0.03	0.00	0.34	0.35	55.3	6.79	3.08	5.39	7.20	1.11	5.36
5	29.5	0.02	0.06	0.35	0.03	0.06	0.43	0.54	6.6	0.01	0.01	0.25	0.03	0.01	0.36	0.35	48.6	1.84	1.25	2.87	0.15	1.77	1.51
6	30.7	0.00	0.11	0.33	0.02	0.09	0.43	0.57	7.7	0.05	0.01	0.45	0.06	0.01	0.48	0.37	44.8	8.12	7.43	6.19	6.74	9.91	5.95
7	22.6	0.00	0.02	0.13	0.00	0.02	0.13	0.37	5.0	0.01	0.00	0.24	0.01	0.01	0.18	0.31	56.6	5.59	3.07	4.94	2.27	3.41	3.46
8	26.3	0.00	0.02	0.13	0.01	0.02	0.26	0.46	6.1	0.02	0.01	0.31	0.01	0.01	0.19	0.33	55.3	0.51	2.59	2.11	0.01	1.54	1.23
9	27.7	0.01	0.03	0.26	0.02	0.05	0.36	0.50	6.9	0.00	0.02	0.18	0.04	0.01	0.40	0.35	52.6	3.42	2.46	3.94	2.07	5.49	3.64
10	22.3	0.00	0.02	0.15	0.01	0.01	0.22	0.37	5.3	0.05	0.02	0.45	0.02	0.01	0.29	0.31	74.4	0.00	7.84	2.74	0.14	9.20	3.06
11	17.6	0.00	0.02	0.17	0.00	0.02	0.14	0.25	4.2	0.01	0.01	0.22	0.00	0.00	0.13	0.29	72.0	1.41	6.21	3.38	0.00	10.82	3.22
12	27.4	0.00	0.06	0.24	0.00	0.03	0.18	0.49	6.6	0.03	0.01	0.34	0.02	0.01	0.29	0.35	54.2	6.88	3.28	5.44	7.17	3.17	5.53
13	17.1	0.00	0.01	0.10	0.00	0.02	0.13	0.24	3.6	0.01	0.01	0.20	0.00	0.01	0.16	0.27	90.6	4.27	2.34	4.32	14.82	9.31	8.12
14	22.0	0.00	0.01	0.11	0.00	0.02	0.17	0.36	4.9	0.02	0.00	0.28	0.01	0.00	0.19	0.31	61.6	1.34	3.57	2.93	4.42	4.24	4.59
15	20.8	0.00	0.03	0.17	0.00	0.04	0.18	0.33	4.7	0.01	0.00	0.22	0.00	0.01	0.11	0.30	65.6	0.00	4.62	2.11	0.00	8.66	2.88
16	22.1	0.00	0.00	0.09	0.00	0.02	0.16	0.36	4.8	0.01	0.00	0.23	0.01	0.00	0.16	0.30	67.8	2.43	5.16	3.78	2.84	3.91	3.83
17	19.1	0.00	0.01	0.10	0.00	0.01	0.09	0.29	4.0	0.01	0.00	0.19	0.00	0.00	0.13	0.28	77.9	8.33	9.41	6.41	9.32	5.84	6.44
18	17.7	0.00	0.01	0.10	0.00	0.01	0.08	0.25	3.6	0.01	0.00	0.16	0.00	0.00	0.10	0.27	95.0	5.62	11.53	5.71	0.00	16.63	4.00
19	19.7	0.00	0.01	0.09	0.00	0.01	0.10	0.30	3.9	0.01	0.00	0.18	0.00	0.00	0.10	0.28	76.4	0.24	10.26	3.28	0.00	13.81	3.64
20	19.9	0.00	0.02	0.13	0.00	0.02	0.14	0.31	4.4	0.01	0.00	0.24	0.01	0.00	0.23	0.29	72.8	5.23	2.79	4.77	6.79	1.93	5.29
21	23.7	0.00	0.02	0.13	0.00	0.01	0.12	0.40	5.6	0.01	0.01	0.26	0.01	0.01	0.20	0.32	55.9	5.53	5.18	5.12	6.38	4.79	5.40
22	22.0	0.01	0.01	0.20	0.00	0.01	0.17	0.36	5.0	0.02	0.00	0.30	0.01	0.01	0.26	0.31	63.9	8.13	6.96	6.16	12.64	4.14	7.25
23	26.3	0.00	0.04	0.20	0.00	0.04	0.20	0.46	6.7	0.01	0.01	0.26	0.01	0.01	0.23	0.35	58.7	1.97	6.02	3.65	2.95	3.04	3.78
24	27.1	0.00	0.05	0.21	0.03	0.01	0.34	0.48	7.0	0.01	0.02	0.24	0.01	0.02	0.25	0.36	59.3	5.42	2.66	4.83	4.27	6.32	4.74
25	26.8	0.06	0.01	0.47	0.05	0.02	0.46	0.47	6.5	0.04	0.01	0.41	0.04	0.02	0.40	0.34	53.2	1.93	4.34	3.41	0.61	3.34	2.36
26	24.9	0.00	0.02	0.14	0.00	0.04	0.19	0.43	5.6	0.00	0.01	0.15	0.00	0.02	0.16	0.32	55.0	1.36	1.34	2.55	0.68	2.38	2.22
27	24.5	0.00	0.02	0.19	0.00	0.03	0.16	0.42	5.9	0.03	0.02	0.34	0.02	0.01	0.32	0.33	62.2	0.00	9.74	3.06	0.35	4.66	2.42
Avg	24.2	0.01	0.03	0.21	0.01	0.03	0.23	0.41	5.6	0.02	0.01	0.28	0.02	0.01	0.25	0.32	61.7	3.42	4.89	4.01	3.86	5.52	4.18

APPENDIX 5

RECOMMENDED CHANGE TO THE TEXT OF IWTO-47

2. SCOPE

This Specification sets out the procedures for obtaining the mean and distribution of the fibre diameter of a sample of wool using an OFDA. **This method is applicable to the OFDA 100, and the OFDA2000 but ONLY when used in 100 mode in a laboratory environment satisfying the conditions detailed in the Essential Requirements.** The procedures also include methods for drawing subsamples and preparing test specimens of fibre snippets mounted on glass slides from the subsamples.