FIBRE STATS: DOES THE MACHINE REALLY MATTER?

By Ian Davison & Cameron Holt © 2006

For those seeking a short answer: **NO**.

There is no significant difference in the results of measurements for micron made on midside fleece samples between different types of machines.

But the answer can be made longer. **Curvature, when measured using the same samples, showed significant variations between optical and laser methodology**.

And some variation in one of the optical methods proved less reliable when trying to assess whole fleeces using grid samples. This was due largely to the methodology of pre-test sample preparation.

To better understand the discussion, one must first understand the different methods used for measuring fibre, and their application in different types of testing machines.

Most Australian wool offered for sale today is tested before sale. Processors demand accuracy in the testing of fibre so that they can accurately batch (match) and blend the fibre to produce a yarn of a given specification. The technique preferred by the wool industry is the airflow method, whereby a given weight of fibre (2.5 gms) is subjected to a stream of air under carefully controlled conditions, and the fineness calculated as a function of the resistance of the sample to airflow. Larger diameter fibres present a larger surface area to impede airflow, giving greater resistance, whilst finer fibres produce less resistance to the stream of air.

This process, whilst economical, measures only mean fibre diameter. It does not measure variation within the fibre. It is less suited to use with alpaca because of the presence of some medullated fibre in alpaca fleece, which means that an increase in fibre diameter is not always reflected by an increase in fibre mass. This assumption, reasonably made with respect to sheeps' wool, is fundamental to the principal by which the airflow machine measures fibre diameter. Furthermore, because of the lower scale height of alpaca fibres, they offer less resistance to airflow than sheep fibres of similar diameter, and machines used for wool need to be recalibrated for alpaca.

Airflow machine

A number of processors are now paying a premium for wool that has a low CV. These wools have to be measured on testing machines that can calculate SD and CV. Wools, which have a CV of lower than 24%, produce a yarn that performs like a finer yarn due to their evenness of fibre diameter (spinning fineness).

Almost all alpaca fibre tests currently performed are called "Guidance Tests", because the results are not certified. Only those tests performed by a certifying authority (eg. Australian Wool Testing Authority) can be called Certified Tests, in which case the certifying authority itself samples, measures and weighs the fleece or bale. This type of test is used in the wool industry, as well as for the sale of other commercial fibres (including alpaca), when offering baled fibre for sale. The vast majority of alpaca fibre tests that are performed are done on samples taken by the breeder and then submitted for testing, and are hence uncertified "guidance tests." The testing procedure is, however, essentially the same as that used for certified tests, and the standards by which those machines operate are also the same.

Projection Microscope & General Microscope Method

These methods involve the measuring of 400-600 images of fibres magnified 500 times on to a screen (projection microscope) or an eye piece (general microscope) where they are individually measured by an observer.

These methods are labour intensive and subject to a number of operator errors.

Projection Microscope

General Microscope

However, if the standard methods are followed correctly, the results obtained are accurate, and are capable of giving the user a measure of the distribution of diameters within the sample. Strict rules are prescribed about the preparation of slides, and the scanning of those slides to avoid measuring the same fibre twice, or selecting points within the field of view, which may not be random.

The test results can be expressed in the form of a Histogram, or a mathematical expression of the distribution such as Mean Fibre Diameter (MFD), the Standard Deviation (SD), and its derivative, the Co-efficient of Variation (CV).

Laserscan /Fibre Fineness Distribution Analyser Method

The Laser Scan/F.D.A. is an instrument used for the rapid measurement of fibre diameter that also gives a full diameter distribution.

Prepared snippets of fibre (less than 2mm) in length are dropped into an isoprepenol/water mixture where they are dispersed. The dispersed snippets, still in the solution, are then carried past a light beam, and as the fibres intercept the beam, the amount of light scattered is measured. This light scatter is directly related to the diameter of the fibre, and so the machine can calculate the fibre diameter in microns. Mean fibre diameter, standard deviation, co-efficient of variation are all calculated and a histogram of the variation is printed. The FDA measures up to approximately 80 microns. In some cases, this may be too small a range for the micron spread in the sample.

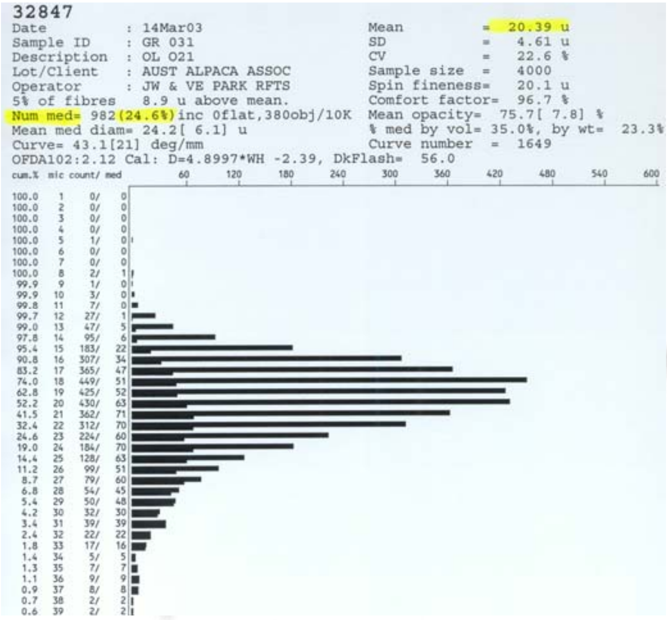
Optical Fibre Diameter Analyser (OFDA) Method

This optical measuring device was developed in Australia and is widely used in testing wool, Cashmere and Mohair.

The OFDA is an automatic microscope above a moving set of fibres. The analyser captures the magnified images of the individual fibres with a video camera. The diameter of each fibre identified is measured and recorded by means of computer aided image analysis. On completion of a pre-determined number of fibres, a histogram print out is produced similar to the Laser Scan/FDA.

The OFDA can identify medullated fibres.

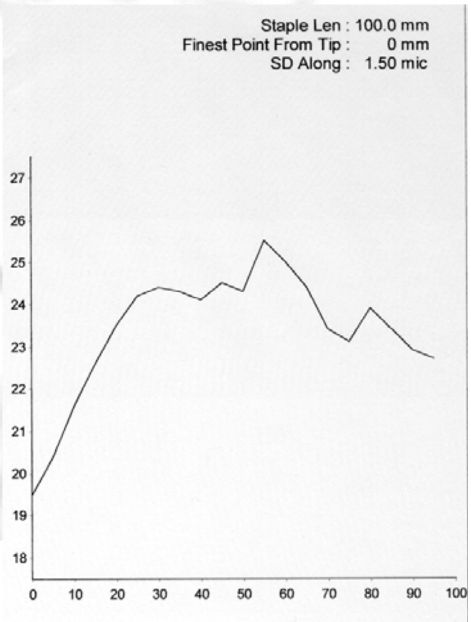
Fibre curvature can also be calculated on the OFDA.



OFDA100 histogram

OFDA 2000

OFDA2000 gives a report based on the entire staple, sampling it along its entire length.



OFDA2000 histogram

All these instruments produce a graph of fibre diameter. The Laser machines and the OFDA 100 produce a histogram, indicating the number of fibre measurements recorded in a sample for every possible fibre diameter value in a range (from zero to 60 or more microns). The highest peak or the micron with the greatest number of fibres recorded against it is called the mode (the most commonly occurring value). When the mean (average) and mode are similar then the shape of the histogram is said to have a bell shaped curve which indicates an even spread of the population around the mean. The OFDA 2000 produces a graph, which records the average fibre diameter of the staple, measured at different distances along the staple from the skin. Variations in the fibre diameter along the staple may be interpreted as representing variations in the health, nutrition or climate enjoyed by the animal at the time the fleece was grown.

USING TEST RESULTS

A note of caution to <u>all</u>. When using results to compare one animal with another, a number of factors need to be considered.

1. Some research and anecdotal evidence suggests alpacas increase 2 to 3 microns each year in its first 3 years and then tend to remain static.

2. Genotype is likely to be an influential factor in the rate and extent of fibre blow-out with age.

3. Nutritional intake/stress/illness/pregnancy will also affect fibre growth and fibre diameter.

4 When measuring fibre there can be small differences between results, brought about by

    - Variation between samples
    - Variation between machine type
    - Variation between machines of the same type

The Laser and OFDA 100 used in the laboratory have IWTO accreditation and are approved for certified measurements.

<u>NOTE:</u> Different properties will exhibit pastures of different nutritional value. If identical animals were to be reared on those properties, it can be reasonably assumed that their fleeces will show different characteristics on fibre measurement, reflecting those nutritional variations. The same applies to animals reared on the same property, where some are fed supplementary feed, and others are left to graze and forage. So, when comparing animal tests results on your property, you need to consider the four vital parameters, which affect fleece growth:

Age
Genotype
Health
Nutrition

So in considering any single fibre test, note firstly the *date of sampling* (which is not the same as the date of testing), and therefore the age of the animal at testing; the nature of the sample (grid of whole or skirted fleece, or single site from midside or elsewhere), and the condition of the animal's health and nutrition at the time of sampling. Only where these factors are comparable can a fleece test be presumed to reflect a truly genetic difference between animals.

STUDY INTO COMPARATIVE DIFFERENCES OF SCIENTIFIC TESTING MACHINES USED IN ALPACA FIBRE MEASUREMENT

This study aims to test the comparability of those techniques in measuring alpaca fibre, and thereby validate their use in comparing fibre measured by different techniques.

SUMMARY OF RESULTS

INTRODUCTION

By way of background, it should be understood that:

1. OFDA100 and LASER (LAB) machines used in this experiment have been approved for fibre measurement by International Wool Testing Organisation (IWTO).
2. No two testing machines will give exactly the same results, particularly when they employ different methods, although approved machines will measure to within an acceptable tolerance.
3. No two-fibre samples are exactly the same, even when a single sample is divided in two to produce two separate samples.
4. The grid sample is taken (in this study) from a skirted fleece and the midside sample is taken from an unskirted fleece (note position on alpaca) and therefore a slightly coarser micron would be expected in the midside sample.
5. The Laser Inshed technique is suitable only for whole fleeces.

REPORT

1. When comparing the grid samples of OFDA 100 (lab) and OFDA 2000 (in-shed), there was a large variation with a mean magnitude of difference (MMD) of 1.1 microns. After discussions with operators of the OFDA 2000 this difference was considered to be due to the preparation of the subsample required for testing.

   INFERENCE: Subsampling a grid sample is likely to produce considerable variation in the composition of the subsamples, and the sampling technique is more likely to be responsible for the wider variation in these results than the accuracy of the machines measuring them.

2. Comparison of the grid sample and the midside sample, both measured by the OFDA 00 (lab), shows a bias three times the standard error, which was significant (that is, a mean difference of this magnatude is unlikley to occur just by chance). This probably reflects the midside sampling on an unskirted fleece and grid sampling on a skirted fleece. The mean magnitude of difference (MMD) was 0.87 microns and showed a consistent scatter when plotted.

   INFERENCE: The grid sample was finer than the midside sample when both samples were tested on the OFDA 100 (lab). This is a real difference that is determined by the sampling methods (midside on alpaca / grid on skirted fleece).

3. Comparison of the grid and midside samples, both measured by the OFDA 2000 (in-shed), showed a large scatter and had a large MMD of 1.26 microns. It is considered that a single site sample (midside) was more reliable than the grid due to possible subsampling errors in the latter. Refer to methods of test houses (OFDA 2000).

   INFERENCE: As noted in (1) above, the technique of subsampling the grid sample is the likely cause of the wide variation between the midside measurements and the grid *measurements, and is a reflection of the unreliability of that subsampling technique for a gridded sample.*

4. Comparison of the grid samples measured by OFDA 100 (lab) and the midside samples measured by OFDA 2000 (shed) revealed a MMD of 0.82 microns.

   INFERENCE: Measurements taken on grid samples (skirted fleece) measured by OFDA in the lab, with midside samples measured by OFDA in the shed, are two separate populations. The midside is representative of an unskirted fleece (this implies that parts of the middle leg areas of the fleece are included), whereas the skirted fleece has had the coarser areas removed.

5. The comparison of midside samples measured by the two OFDA techniques, lab and in-shed, showed a very tight scatter, with microns (between compatible samples) being within a 2 micron difference. The slope is significantly less than one to one, which may indicate a difference in performance between the individual machines. The opinion is that measurement of a midside (single site) by the OFDA 2000 is validated.

   INFERENCE: This is a validation of the OFDA in-shed technique for the measurement of midside samples.

6. The comparison of the Laser (in-shed) technique, applied to a whole skirted fleece, and the Laser (lab) technique, applied to a grid sample of the same fleece, demonstrated a reasonable correlation between the two, with a very slight bias to fineness in the former. Scatter was minimal, allowing for two outliers, with an overall MMD of 0.90 microns. Coring, turning the fleece and re-coring the fleece, may reduce this difference in fineness, when using the Laser (shed) technique.

   INFERENCE: Comparison of measurements taken on a whole fleece measured by Laser in the shed with those taken on a grid sample by Laser in the lab, is valid.

7. Finally a comparison of the measurements made on a grid sample by OFDA 100 (lab) and Laser (lab) was made. The MMD was 0.95 microns with a consistently tight scatter. The laser consistently gave a lower micron reading by a factor of 0.87.

   INFERENCE: This validates the alternative use of OFDA or Laser lab techniques in measuring a given fleece sample, though the Laser overall in this trial was inclined to give results slightly biased to fineness. <u>Other trials have shown these machines to produce consistent and compatible results.</u>

8. It was noticed that between the OFDA and laser machines, a large difference for curvature was observed (17.82 degrees per mm). The laserscan gave the higher measurements (average curvature 53.39 degrees per mm) compared to the OFDA (35.58 degrees per mm).

   INFERENCE: The correlation between curvature measured by OFDA or laser for any one sample is poor, with OFDA measuring significantly lower curvature than Laser. The significance of difference in curvature measurements between machines suggests that meaningful comparisons of fibre curvature between different fleeces can only be made if measured by the same techniques.

RECOMMENDATIONS

GENERAL

Following the analysis of results with the OFDA 2000 (grid sample), discussions took place with the operator of the laboratory concerning sub-sampling methods, and also with management of IWG (agents for the OFDA 2000), and it is jointly recommended that:

1. Grid samples must be clearly identified as such.
2. Grid samples should be tested on the OFDA 100, or the OFDA 100 *mode* of the OFDA 2000, until satisfactory sub-sampling protocols are developed for the OFDA 2000.

Following discussions with the operators of the in-shed laser scan regarding the two outlier results, it is recommended that (due to the large variation generally found in alpaca across the whole fleece) two corings of the fleece be carried out to improve the accuracy of the sub-sample.

BREEDERS

It is recommended to alpaca breeders that

1. Any sample being sent for testing, at any test house and by any method, should clearly identify whether it is a mid or grid sample.
2. Grid samples (at this stage) are not tested using the OFDA 2000 method until a satisfactory sub-sampling method is invoked.
3. If measuring and recording curvatures, breeders should select and stick with one or other of the OFDA or laser format due to the variances in recording by these machines.

ORGANISERS OF ALPACA FLEECE SHOWS

Where measurement is required and the 6-point grid procedure is used, the following options should be implemented.

1. Send samples to a laboratory that is using an OFDA 100 or 100 mode, **OR** . . ..
2. Send samples to a laboratory that is using the laser scan, **OR** . . .
3. Engage operators of the laser scan in-shed system where fleeces are cored on site. Note – it is recommended that double coring take place to improve the sub-sample that is used for testing.

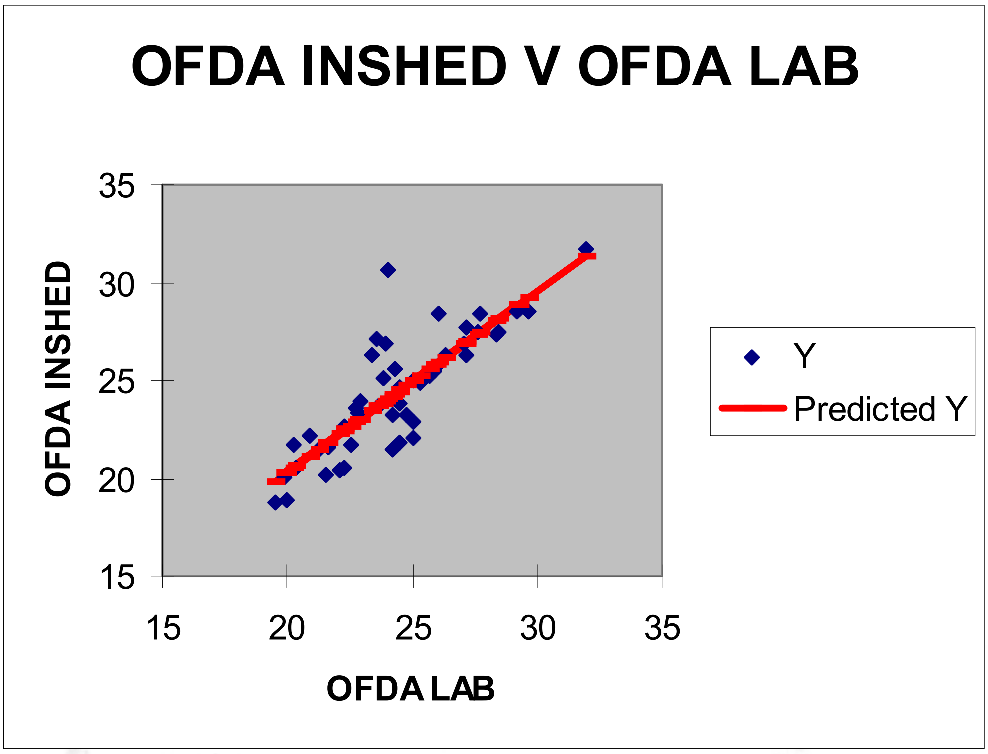
Special thanks to Professor Brian Sawford (Monash University) for his help in calculating and analysing the results of this study.

FOR THE MATHEMATICALLY INCLINED,

DATA

COMPARISONS		MEAN MAG OF DIFF	S D	AVE DIFF	STD ERROR OF AVE DIFF	BASE AVE MIC (X)	OTHER AVE MIC (Y)	BASE ave Finer/ Coarser Than other	R SQ	INTERCEPT		X SLOPE	
BASE (X)	OTHER (Y)									CO-EFF	STD ERROR	CO-EFF	STD ERROR
OFDA LAB GRID	OFDA INSHED GRID	1.165	1.694	-.011	0.24	24.51	24.50	C 0.01	0.7078	1.8747	2.1337	0.9230	0.0865
OFDA LAB GRID	OFDA LAB MID	0.876	1.080	.435	0.15	24.51	24.94	F 0.43	0.8826	-0.5553	1.3652	1.040	0.0553
OFDA INSHED GRID	OFDA INSHED MID	1.265	1.758	.232	0.25	24.50	24.73	F 0.23	0.6927	5.4532	1.8871	0.7867	0.0764
OFDA LAB GRID	OFDA INSHED MID	.820	1.075	.219	0.15	24.51	24.73	F 0.22	0.8673	1.0549	1.3592	0.9658	0.0551
OFDA LAB MID	OFDA INSHED MID	.706	0.888	-.216	0.13	24.94	24.73	C 0.21	0.9203	2.3164	0.9688	0.8984	0.0385
LASER LAB GRID	LASER INSHED FLC CORE	.901	1.112	-.344	0.16	23.72	23.38	C 0.34	0.8198	2.685	1.423	0.8722	0.0596
OFDA LAB GRID	LASER LAB GRID	.952	0.841	-.785	0.12	24.51	23.72	C 0.79	0.9133	2.2683	0.9701	0.8754	0.0393

MACHINE USED	AVE MIC	AVE CV	AVE CURVE	COMMENTS
OFDA LAB	24.51	22.80	37.31	)) AVE CURVE = 35.58
OFDA INSHED	24.50	20.37	33.85	) Difference between LASER and OFDA) was 17.8 deg. SD(4.49) R SQ (0.278)
OFDA INSHED MID	24.73	19.57	32.92	INTERCEPT: CV(13.132) SE(5.295) X VARIABLE : CV(0.420) SE (0.099)
OFDA LAB MID	24.94	21.66	34.77	
LASER LAB	23.72	22.28	51.16	)) AVE CURVE =53.39
LASER INSHED	23.38	21.55	55.63	))


OFDA INSHED V OFDA LAB
OFDA INSHED
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OFDA LAB
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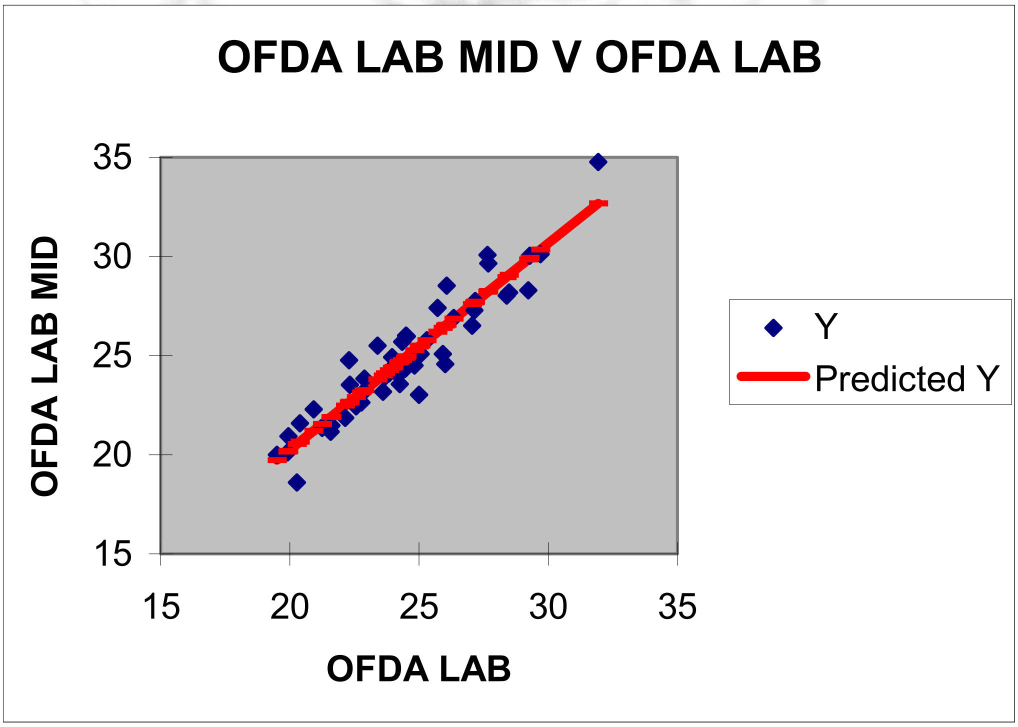
Predicted Y


OFDA LAB MID V OFDA LAB
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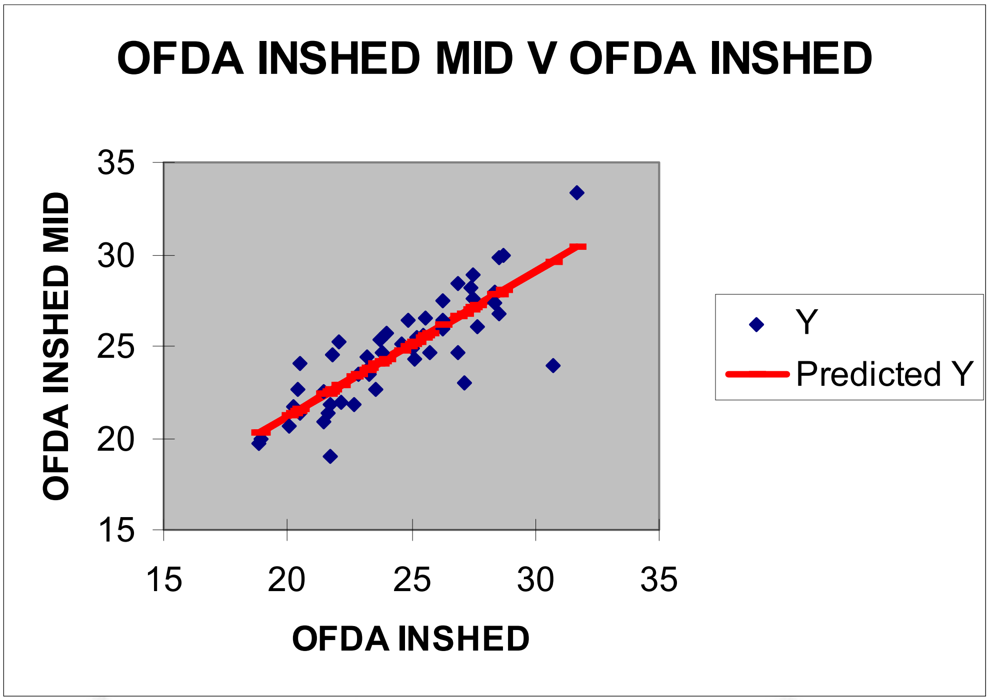
OFDA INSHED MID V OFDA INSHED
OFDA INSHED MID
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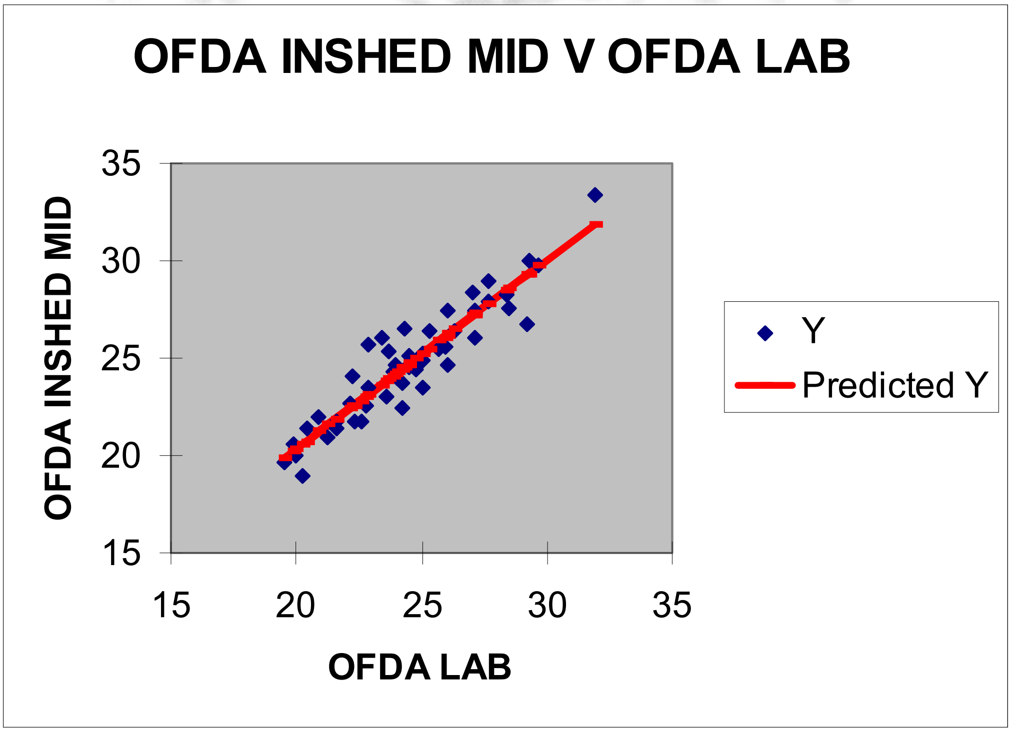
OFDA INSHED MID V OFDA LAB
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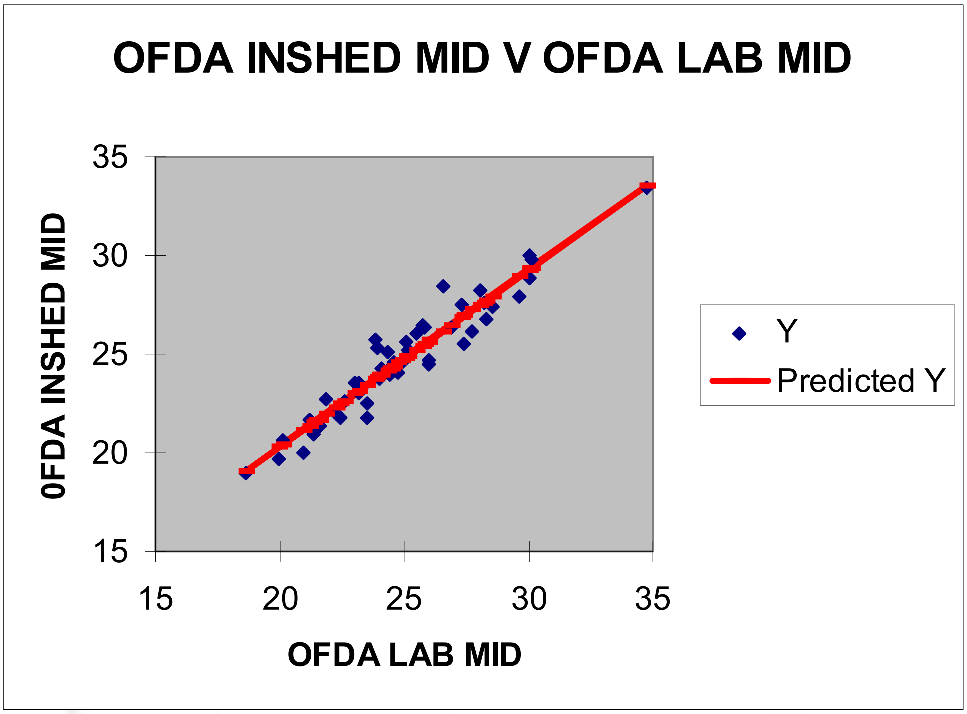
OFDA INSHED MID V OFDA LAB MID
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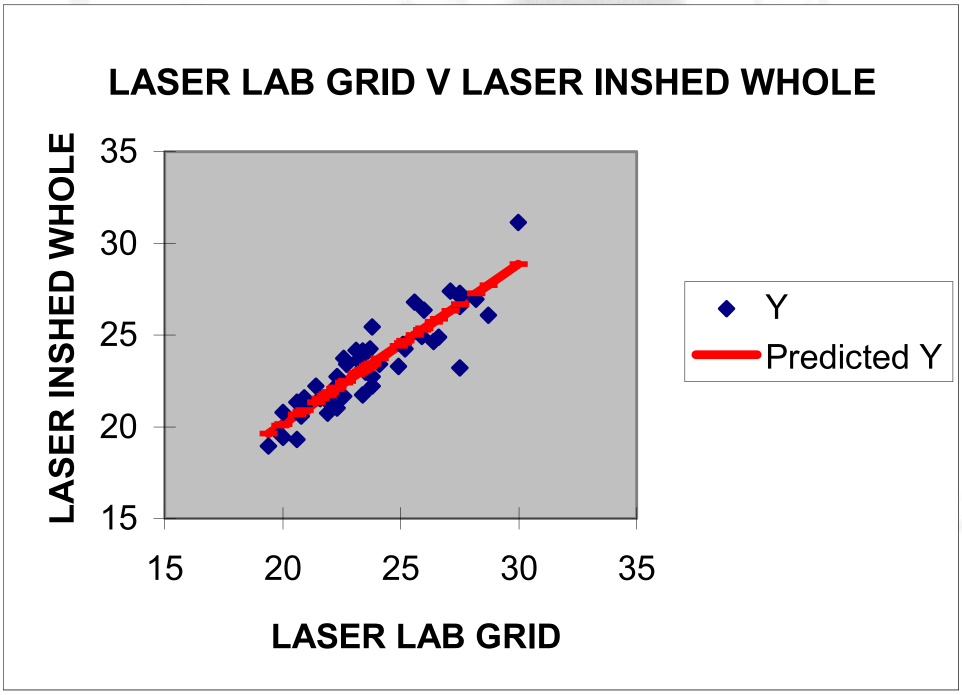
LASER LAB GRID V LASER INSHED WHOLE
LASER INSHED WHOLE
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LASER LAB GRID
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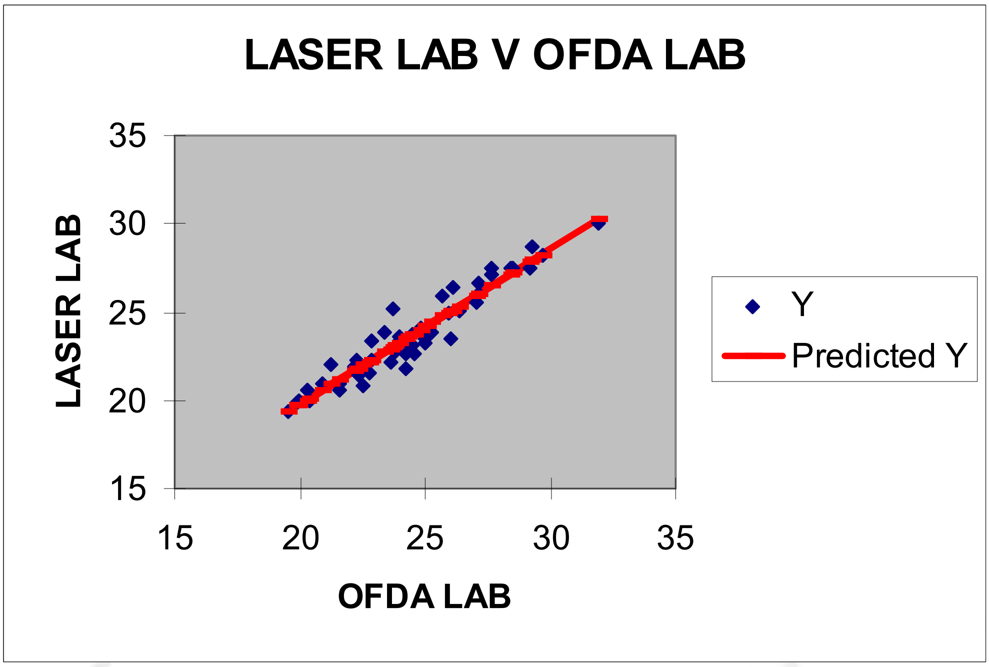

LASER LAB V OFDA LAB
LASER LAB
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OFDA LAB
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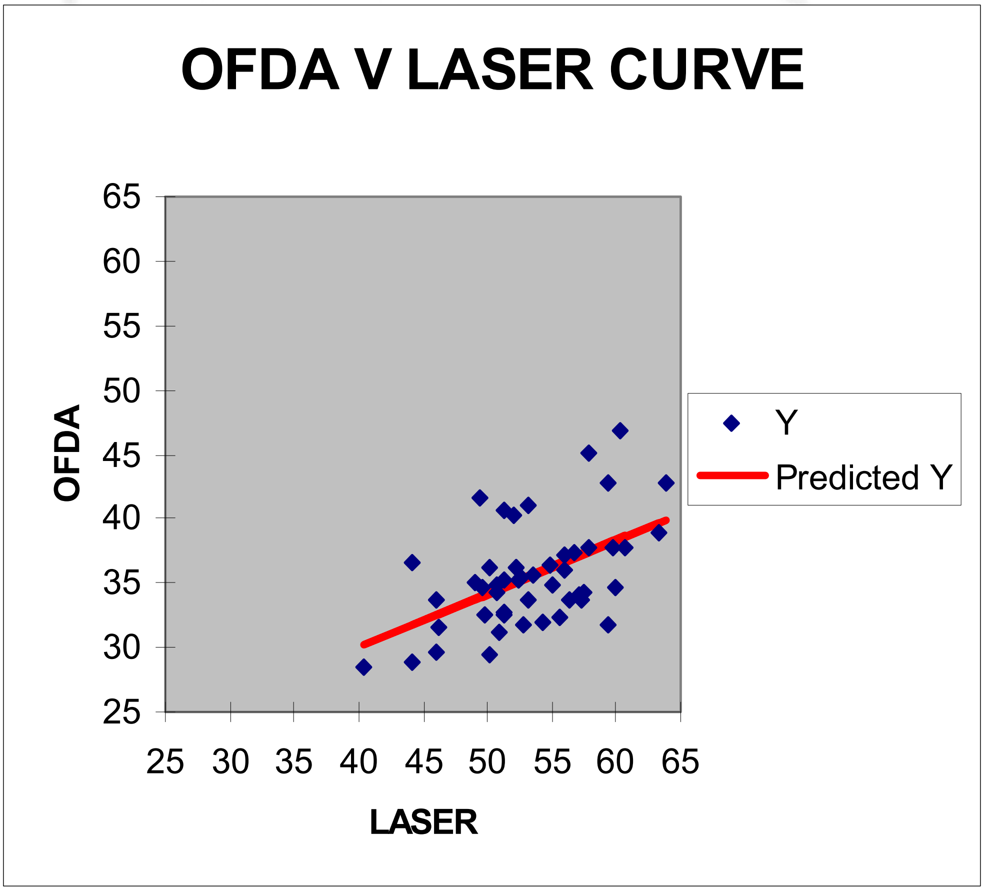
Predicted Y



OFDA V LASER CURVE
OFDA
65
60
55
50
45
40
35
30
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25 30 35 40 45 50 55 60 65
LASER
Y
Predicted Y

FURTHER READING

Study into comparative differences of scientific testing machines used in alpaca fibre measurement (report to A.A.A.)
Dr Ian Davison & Cameron Holt 2004

Components of Alpaca (Lama Pacos) fleeces and the potential of inshed measurement of fibre diameter.
A.C. SCHLINK & A.M. MURRAY CSIRO Livestock Industries, W.A.

Performance of the OFDA 100 compared to other instruments –
IWG (Interactive group), Fremantle W.A.

Fleecescan and OFDA 2000 Trial
Andrew Peterson, Agricultural Department, W.A.

OFDA2000 Proficiency trials
Peter Baxter, Bill Johnston. IWTO Report no CTF 01 2002