A SURVEY OF

THE RELATIONSHIPS OF

CRIMP FREQUENCY, MICRON, CHARACTER & FIBRE CURVATURE

A Report to the Australian Alpaca Association

by

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INTRODUCTION

Fibre curvature is the measure of the fibre crimp frequency and amplitude There is a reasonable correlation between fibre curvature and staple crimp frequency (sheeps wool). The curvature value is expressed in degrees per mm fibre length. As the frequency of the crimp increases, in general the curvature value is increased, and conversely the lower the curvature value the lower the staple crimp frequency. Fibre curvature can be measured at all stages of processing e.g. greasy to fabric.

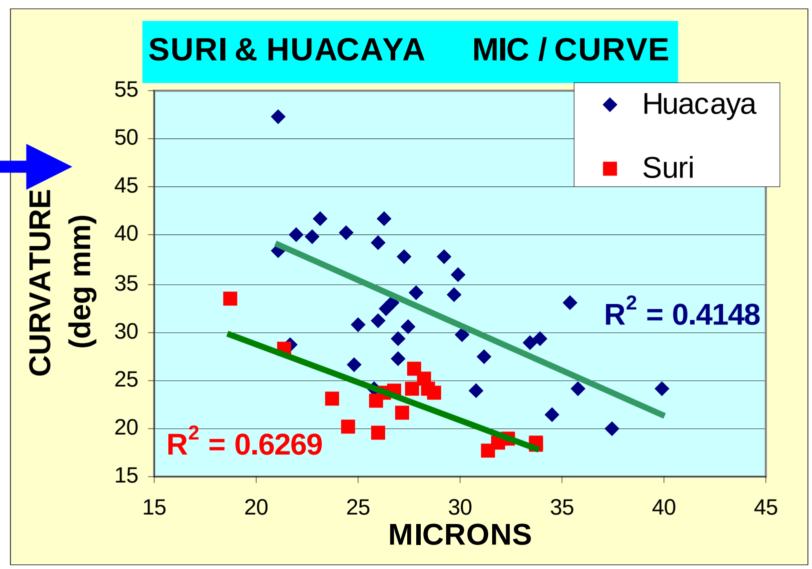
The curvature of the fibre influences how the fibre will process, particularly during top making and spinning.

Expression of character is not measured with the curvature reading.

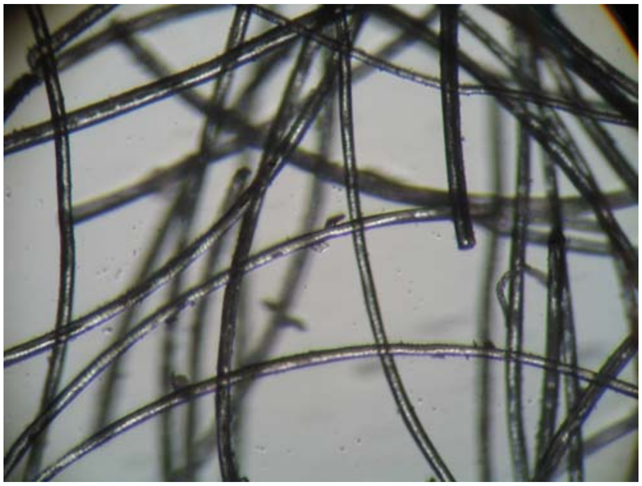
Curvature (ofda) values in Suris have tended to give a range from 15 to 35 deg mm with the Huacaya showing a range from around 25 to 60 deg mm. It was noted that the coarser the micron, generally the lower the curvature value. Also in Suris (Holt/Scott 1994) when the C of V was more variable (higher) the curvature value also tended to be lower.

Dr Paul Swan has identified that for sheeps wool of low crimp frequency, curvature readings were 60 degrees per mm and up around 130 degrees per mm for superfine wool. As you can see the alpaca (Huacaya) slips in at the 60 degree area and below.

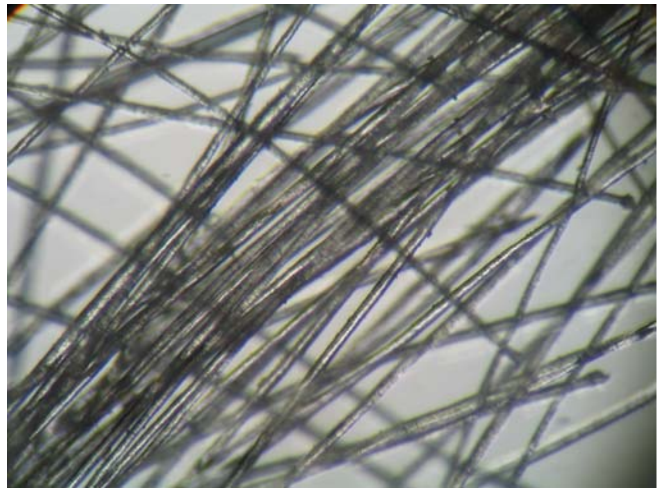
The graph, formulated from measurements in the study (Holt/Scott 1994), show the spread for micron and curvature in both suri and huacaya. The huacayas had a .64 correlation, whilst the suri had .79 correlation.



The following photos demonstrate the curvature in both Suri and Huacaya fibres.



HUACAYA (X120)



SURI (X120)

RATIONALE

The aims of this study are to establish any relationships between crimp and curvature. To also identify any effects that micron, crimp frequency and definition of character may play in the expression of curvature in the alpaca fibre. This study also aims to test the comparability of curvature results (between OFDA100 and LASER SCAN) in measuring alpaca fibre. An analysis of some 5000 results on the AAA database to compare the results of "Micron to Curvature" averages between the main study and a large population of alpacas.

OBJECTIVE

1. Identify 261suitable Huacaya alpacas of various types for assessment. The alpacas should be mixed for crimp types. (study 1)

2. Identify 100 suitable Huacaya alpacas of various types for assessment of curvature values. (studyl 2)

3. Machines to be used in this study

   - OFDA 100 (study 1&2)
   - LASER SCAN (study 2)

4. Analyse AAA database (2000 – 2002 data), to acquire averages where possible for micron and curvature comparisons. (OFDA100 tested) (study 3)

STUDIES CONDUCTED

Study 1
Some 261 fleece measurements from huacayas in Australia and from the USA were taken. The alpacas varied for age and fleece type. The total samples included excellent fleece types (with a character score of "1"), and through to inferior types which had a character scoring of "6". The results from these alpacas form the basis of this study. There were no "true alpaca SRS" types in this study, although a few showed a tendency towards this type.
Consider this when interpreting the data, as data from other herds/alpacas may vary due to outside influences.

Study 2
100 fleece measurements from huacayas in Australia were taken. The alpacas varied for age and fleece type.

Study 3
Some 5000 tested results (OFDA) of Australian alpaca fleece stored on the Australian Alpaca Association database were analysed. The white population in both huacaya and suri were separated to get more consistency of results. Averages based on age and colour for huacayas were also analysed for comparison only.

MATERIALS AND METHODS

SAMPLING

1. Select 261 suitable huacaya alpaca samples (main curvature study) (OFDA)

2. Select 100 suitable huacaya alpaca samples (OFDA/LASER SCAN curvature trial)

3. Identify and sample from fleece. Place sample in plastic bag with identification of animal number and trial.

4. Character to be assessed using the following rating.

   CHARACTER is the expression depth and evenness of the crimp or wave throughout the staple. The character indicates how well the fibres are aligned in the staple (definition of character). A very good character would normally display a lower C of V of micron.

CHARACTER RATING USED IN ASSESSMENT

The ratings for character definition were

1. **Excellent** – very evenly defined crimp with deep amplitude
2. **Good** – well defined and regular crimp formation
3. **Good/Average** – showing good to average crimp definition and regulation
4. **Average** – showing some crimp definition but not as regular as No 3
5. **Poor** – little crimp definition or regulation visible
6. **Inferior** – no crimp definition visible. Straightish fibres (not Suri)

10/9	8	7	6/4	3/2	1/0
excel	good	g/ave	average	poor	inferior

FLEECE JUDGES RATING FOR CRIMP

4. Crimp frequency to be assessed using the following rating.

CRIMP FREQUENCY is the expression of the number of times the fibre crimps (waves) per inch. There is a general relation between crimp frequency and micron, but not absolute.

CRIMP FREQUENCY RATING USED IN ASSESSMENT

5. Analyse AAA database.

TESTING PROCEDURES

OFDA 100

This machine is regularly calibrated using standardised tops and commercial wire slides developed for this procedure.
A sample is received and identified and is sub sampled using mini core equipment. The 2 mm snippets are then scoured and dried. The sub sample re-conditions for 8 hours prior to being measured on the OFDA 100.
Standard humidity 65%, + - 2% and temperature 20 degrees Celsius + - 2 degrees.

LASER SCAN

Using normal laboratory settings the sample is received and identified. It is then placed in a mini core system and the snippets are then scoured. When this process is finished the snippets are then placed into the **liquid solution in the laser scan (92%Isopropanol – 8% water)** and measured.
Standard humidity 65%, + - 2% and temperature 20 degrees Celsius + - 2 degrees.
NOTE: AWTA now uses liquid solutions of water in the laser scan.

SUMMARY OF RESULTS

INTRODUCTION

By way of background, it should be understood that:

1. OFDA100 and LASER SCAN machines used in this experiment have been approved for fibre fineness measurement by the I.W.T.O. No calibration standard values on the tops used for "micron" calibration are established for fibre curvature measurements. No two testing machines will give exactly the same results, particularly between different types of equipment, although if machines are approved they will be within acceptable tolerance.
2. No two fibre samples are exactly the same.

Only those results of significance were reported

RESULTS STUDY 1

CHARACTER DATA FROM THE 261 ALPACA RESULTS
(Divided into character groups, 1&2, 3&4, 5&6.

	CORRELATIONS			
Crimp rating	*1/6*	*1/2*	*3/4*	*5/6*
Number x/261	*261*	*97*	*88*	*76*
MICRON / CURVATURE	.79	.81	.41	.72
MICRON / CRIMP FREQUENCY	.44	.71	.30	.19
CURVATURE / CRIMP FREQUENCY	.46	.77	.08	.03
CHARACTER/ CV of CURVATURE	.33	.31	.11	.15

AVERAGE RESULTS FOR, MICRON, FREQUENCY, CURVATURE & CV micron (261 ALPACAS).

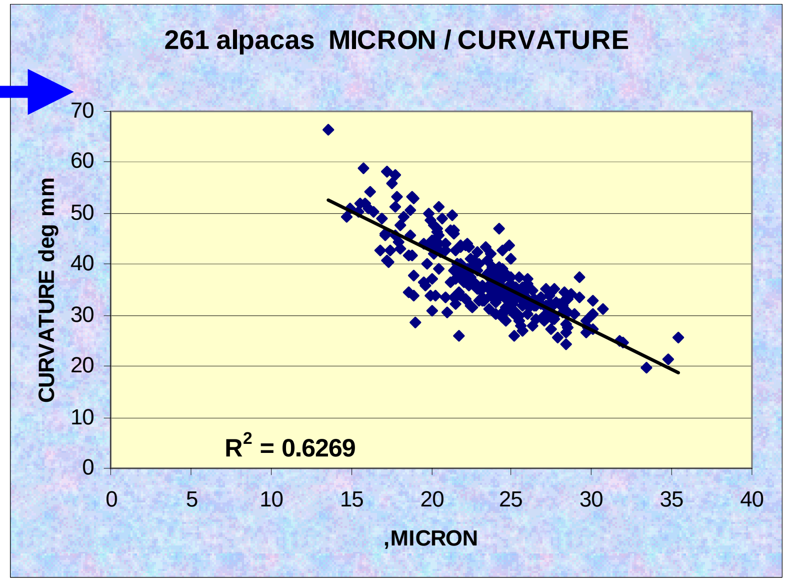
NUMBERS (261) CHARACTER GROUP	AVE MICRON	AVE CRIMP FREQ	AVE CURVE deg sq mm	AVE CV & SD Of CURVE		AVE CHARACTER RATING	AVE CV of MICRON
				CV	SD		
261– 1 / 6	23.49	6.16	37.15	65.4	23.9	3.29	21.36
97 – 1 / 2	21.15	6.58	42.62	61.3	25.7	1.51	21.45
88 – 3 / 4	24.12	5.68	35.30	67.3	23.6	3.27	21.96
76 – 5 / 6	25.82	6.21	32.37	68.4	22.0	5.58	20.57

COMPARISONS CHARACTER GROUP (number)	BASE (X)	OTHER (Y)	R SQ	CORRE-LATION	INTERCEPT	SLOPE
1/6	micron	curvature	.6269	.79	73.70	-1.56
(261)	Crimp frq	micron	.194	.44	30.20	-1.09
	Crimp frq	curvature	.2199	.46	23.11	2.28
1/2	micron	curvature	.6669	.81	77.77	-1.66
(97)	Crimp frq	micron	.511	.71	31.93	-1.64
	Crimp frq	curvature	.6029	.77	18.80	3.62
3/4	micron	curvature	.1732	.41	52.04	-0.70
(88)	Crimp frq	micron	.0894	.30	26.90	-0.51
	Crimp frq	curvature	.0074	.08	33.91	0.24
5/6	micron	curvature	.5171	.72	60.37	-1.08
(76)	Crimp frq	micron	.0363	.19	22.11	0.60
	Crimp frq	curvature	.0012	.03	33.38	-0.16

DATA, GRAPHS & AVERAGES

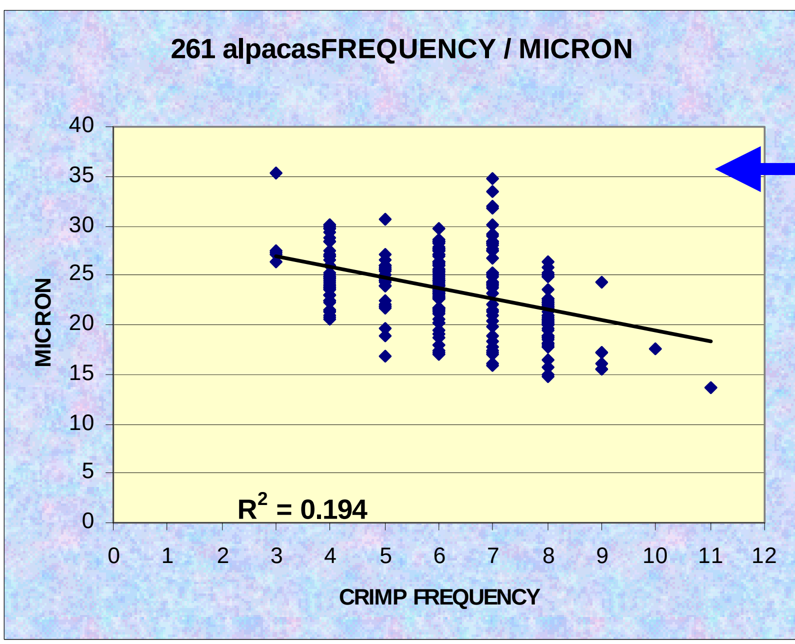
MICRON, CURVATURE SPREAD

This graph



shows the spread and relationship of micron and curvature in the 261 samples. A trend line indicates the approximate average between the micron and curvature. This spread indicated a .79 correlation

(261 alpacas)



This graph

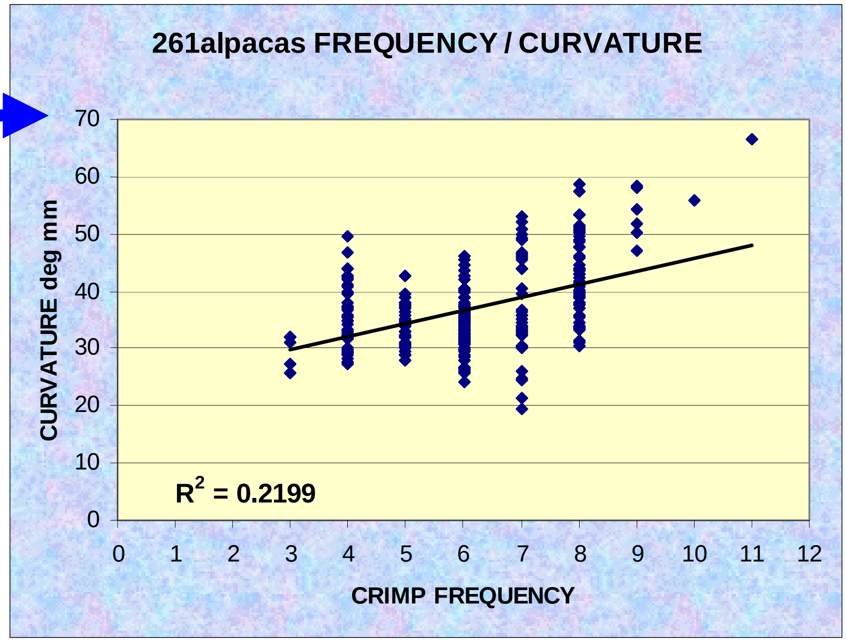
shows the relationship and spread of the micron and crimp frequency. The data indicated a .44 correlation.

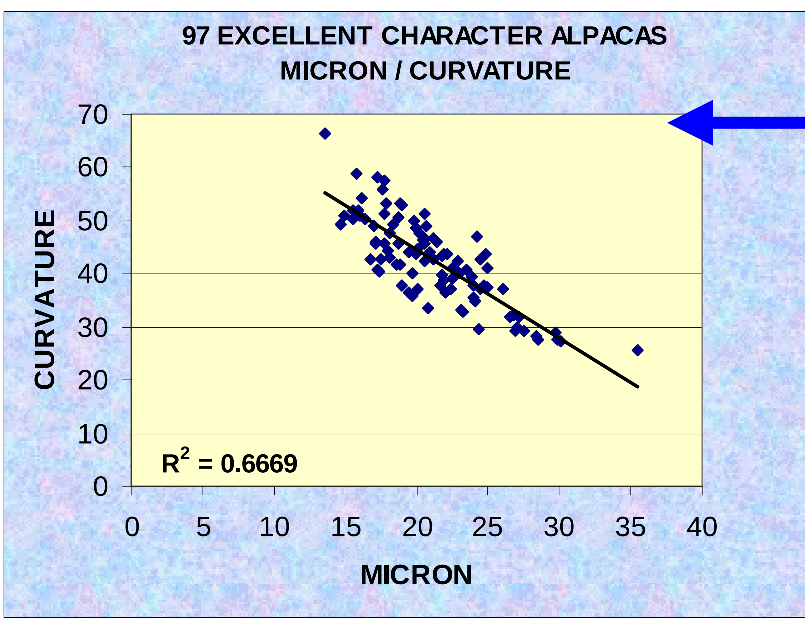
(261 alpacas)

This graph,

shows the relationship and spread of the curvature and crimp frequency. The data indicated a .46 correlation.

(261alpacas)

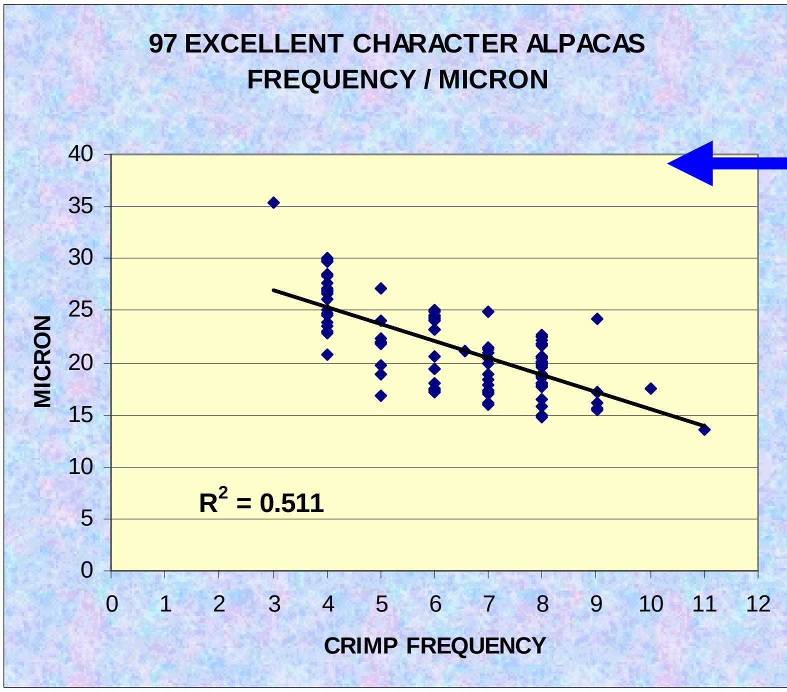




This graph

shows the spread and relationship of micron and curvature in the **97 excellent characted** alpaca samples. A trend line indicates the approximate average between the micron and curvature. This spread indicated a .81 correlation

(97 alpacas)



This graph

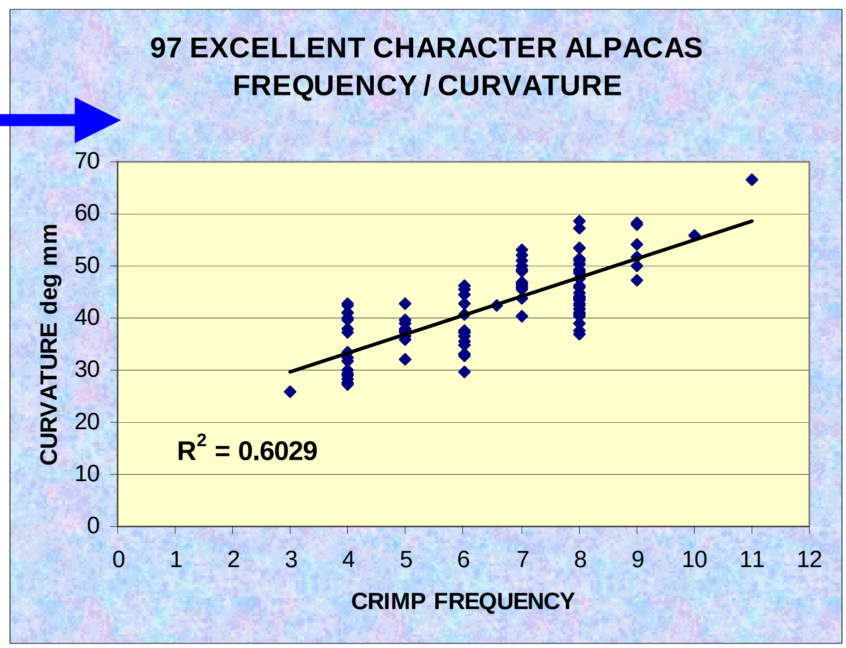
shows the relationship and spread of the micron and crimp frequency in the **97 excellent characted** alpaca samples. The data indicated a .70 correlation.

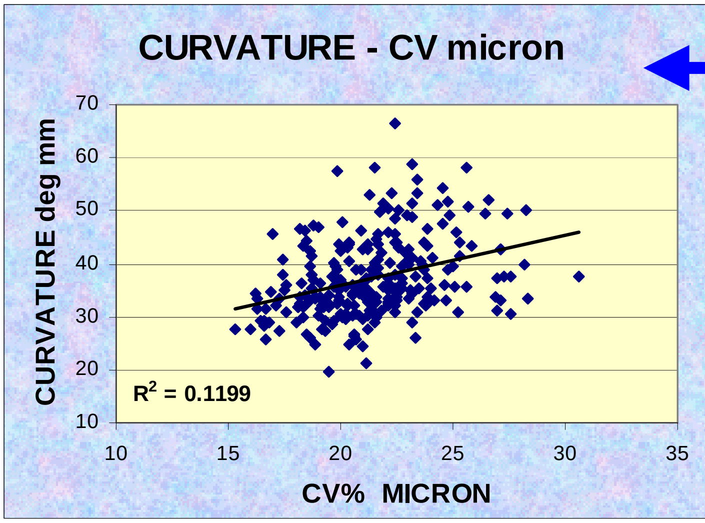
(97alpacas)

This graph,

shows the relationship and spread of the curvature and crimp frequency in the **97excellent characted** alpaca samples. The data indicated a .77correlation.

(97alpacas)





This graph,

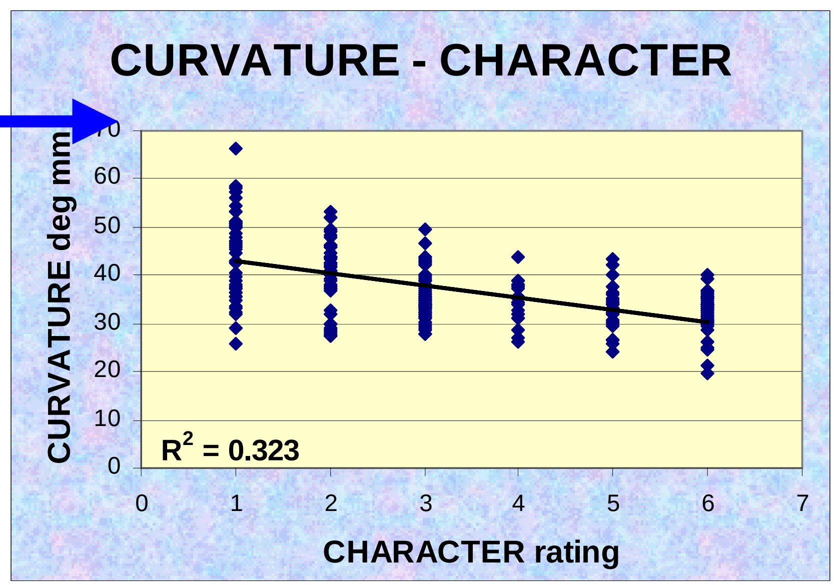
shows the relationship and spread of the curvature and CV% of micron in the **261** alpaca samples. The data indicated a poor correlation of .35.

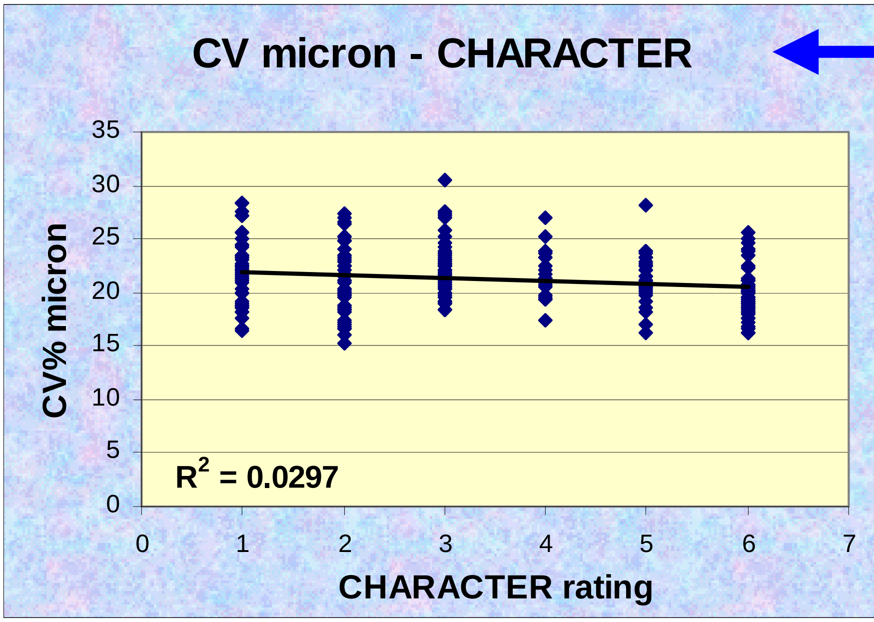
(261alpacas)

This graph,

shows the relationship and spread of the curvature and character rating in the **261** alpaca samples. The data indicated a correlation of .57.

(261alpacas)





This graph,

shows the relationship and spread of the CV% of micron and all groups of character rating in the **261** alpaca samples. The data indicated a meaningless correlation of .17.
The average CV of micron over all was 21.36%.

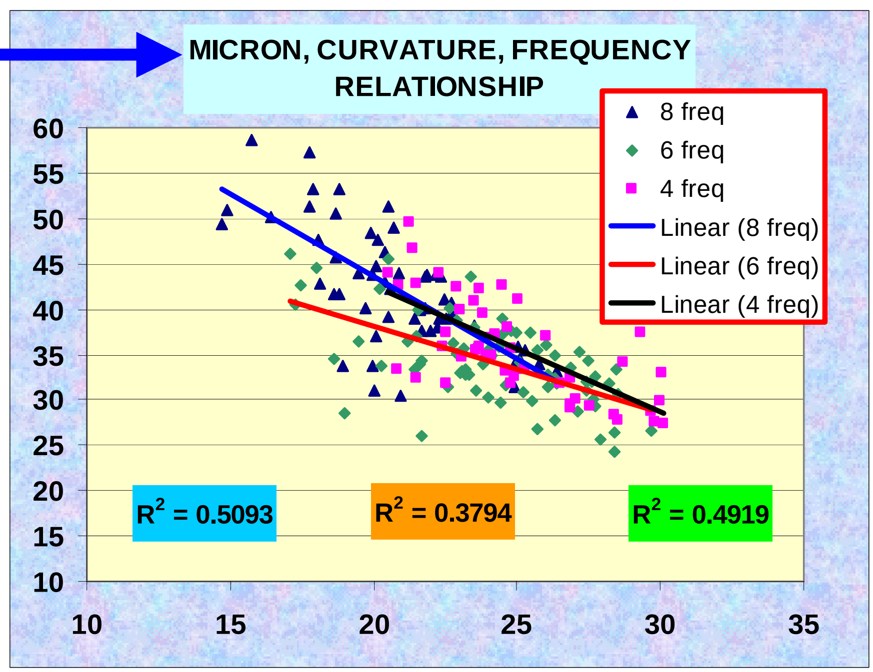
(261alpacas)

This graph

shows the spread for micron and curvature displayed in 3 groups of frequencies (**261 alpacas**)

1. 8 crimps per inch
2. 6 crimps per inch
3. 4 crimps per inch

The 8 crimps per inch indicated a .71 correlation.
The 6 crimps per inch indicated a .61 correlation.
The 4 crimps per inch indicated a .70 correlation.



ALPACA (huacaya)

Regression relationships with crimp frequency for the character group 1 / 2 (97 samples)

Frequency	Curvature	Micron
12	62.24	12.25
11	58.62	13.89
10	55	15.53
9	51.38	17.17
8	47.76	18.81
7	44.14	20.45
6	40.52	22.09
5	36.9	23.73
4	33.28	25.37
3	29.66	27.01
2	26.04	28.65

The above table shows **predicted values for micron and curvature based on the regression relationships with crimp frequency for the character group 1 / 2 (good to excellent character).**

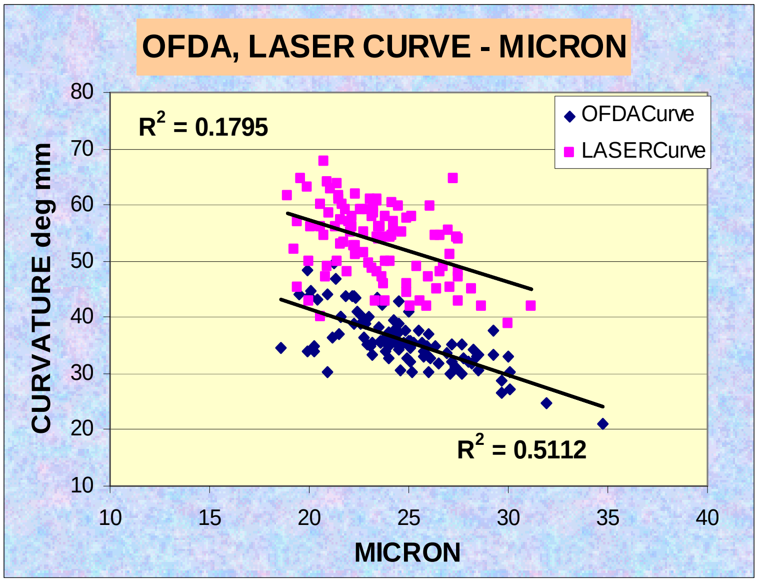
RESULTS STUDY 2

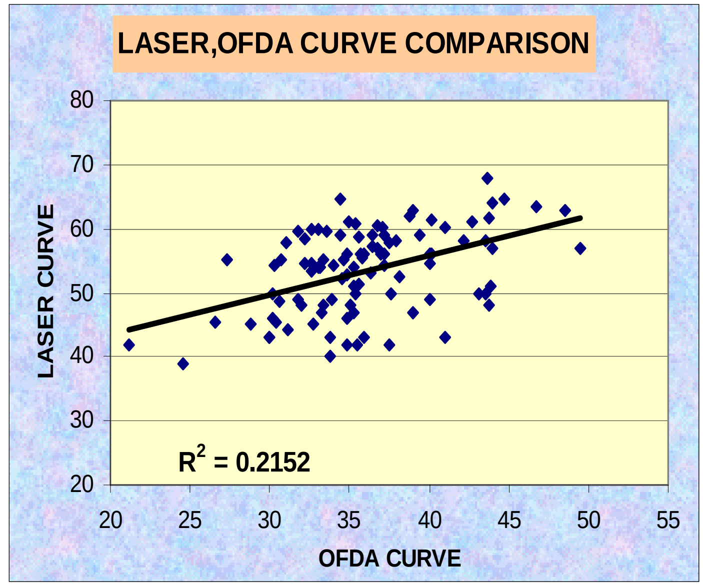
COMPARING OFDA CURVES WITH LASER CURVES (Same 100 HUACAYA FLEECES / SAMPLES tested on each machine)

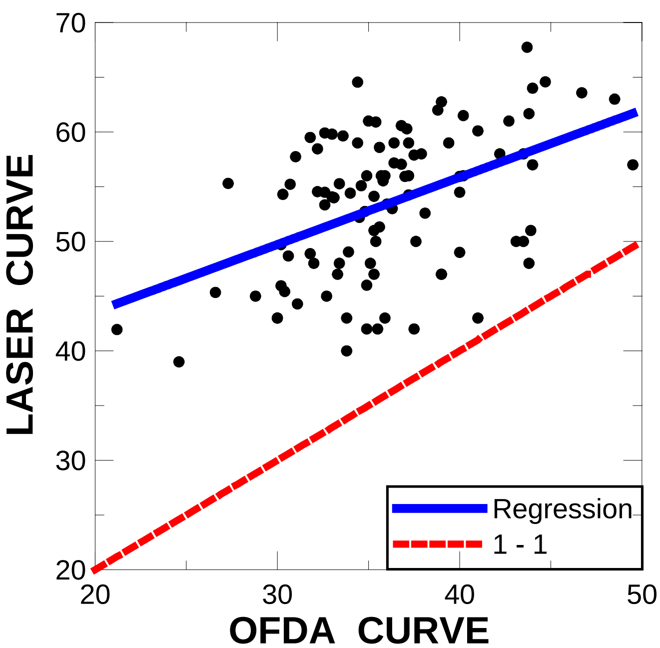
MICRON	AVERAGE MICRON		AVERAGE OFDA CURVE	AVERAGE LASER CURVE	DIFF LASER/ OFDA CURVE	DATA NUMBER	
	OFDA	LASER				OFDA	LASER
19 –20	19.80	19.63	40.12	54.76	14.64	9	9
21 – 22	21.68	21.49	41.27	56.09	14.82	15	29
23 – 24	23.67	23.50	37.29	54.44	17.15	29	33
25 – 26	25.30	25.50	34.48	49.51	15.03	22	13
27 – 28	27.59	27.23	32.50	50.69	18.19	15	13
29 - 30	29.57	28.45	30.95	43.50	12.55	8	2
31 – 34	33.3	31.15	22.90	41.95	19.05	2	1
AVE	24.66	23.51	36.01	53.41	17.4	TOTAL 100	

COMPARISONS			R SQ	CORRE- LATION	INTERCEPT	SLOPE
MACHINE ---------- ave micron - BASE (X)	AVERAGE CURVATURE (Y)	O&L AVE DIFF				
----OFDA –	36.01		.5112	.71	65.34	-1.19
----LASER –	53.46		.1795	.42	79.22	-1.10
OFDA (X)- LASER (Y)		17.4	.2152	.46	31.29	0.61
LASER (X)- OFDA (Y)		17.4	.2152	.46	17.30	0.35

OFDA & LASER SCAN GRAPHS







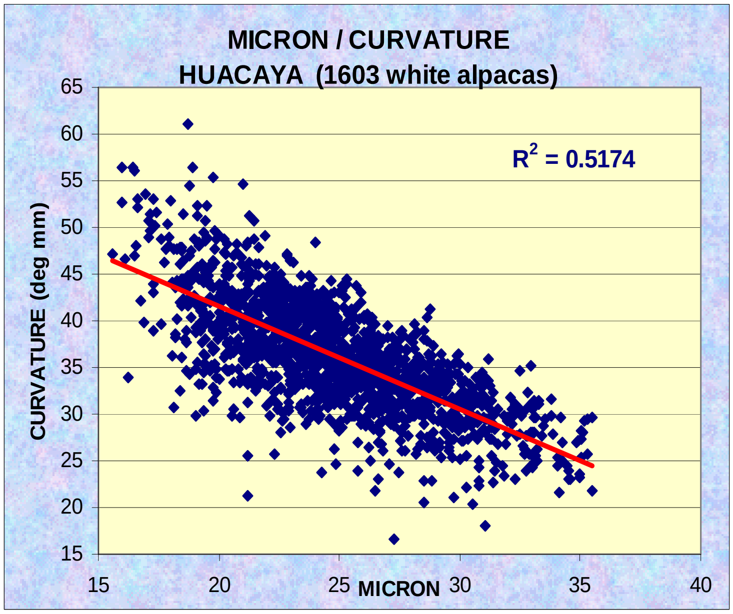
The comparisons between the OFDA and laser for curvature indicated an average difference of 17.4 deg mm (100 huacayas measured in this trial by both machines). The correlation between curvature measured by OFDA or laser for any one sample is poor, with **OFDA measuring significantly lower curvature than Laser**.

The spread of the OFDA was much more consistent than what was found in the laser. However, the comparison of the relationship of micron and curvature for the OFDA still indicated a 49% unexplained variance (.71 correlation). The laser had an 82% unexplained variance (.42 correlation). When directly comparing the OFDA and laser curvature comparisons for each animal there was 78% unexplained variance (.46 correlation)

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.**

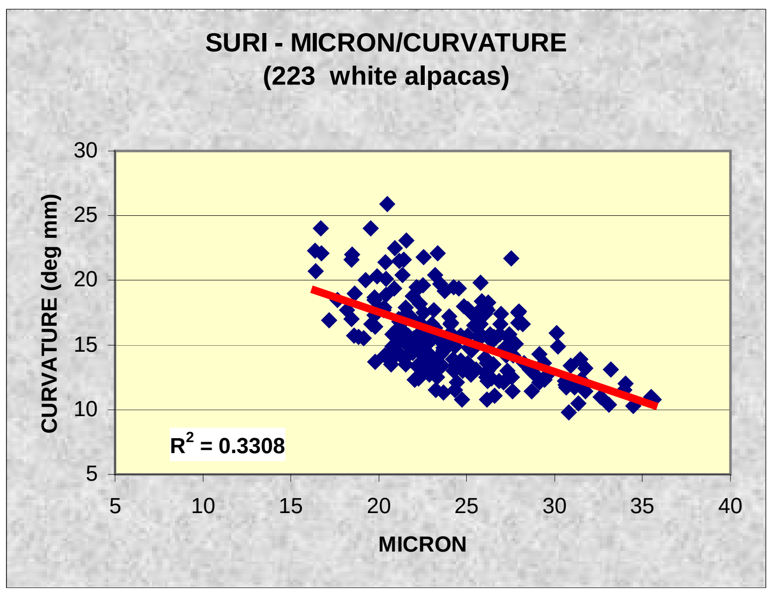
RESULTS STUDY 3

AAA DATA BASE



Huacaya 1603 white alpacas

With a good spread of fibre type in the1603 white huacayas, the data indicated that there was a 48% unexplained variance
(.72 correlation)



Suri 223 white alpacas

With a widespread grouping of animals for fibre style in the 223 white suris, the data indicated a 67% unexplained variance
(.57 correlation)

Averages from AAA data base (NEXT)

HUACAYA CURVATURE - WHITE BY MICRON - 1603 (AAA)

MICRON GROUP	AVERAGE MICRON	AVERAGE CURVATURE	RANGE CURVATURE	SD CURVATURE
16	16.2	49,4	56.5/33.9	28.5
17	17.1	47.7	53.6/39.0	28.9
18	18.3	43.8	52.9/30.8	26.1
19	19.1	42.9	61.0/29.8	25.3
20	20.1	40.8	55.3/29.9	24.4
21	21.1	39.7	54.6/21.3	24.5
22	22.1	38.8	49.1/25.8	23.9
23	23.1	38.2	47.2/28.6	23.7
24	24.1	37.3	48.4/23.7	22.8
25	25.1	35.8	44.4/24.7	23.0
26	26.1	34.5	43.8/21.7	22.2
27	27.0	32.9	39.4/16.6	21.9
28	28.1	32.6	39.6/20.6	22.1
29	29.0	31.8	41.2/22.9	21.5
30	30.0	30.3	36.4/14.8	20.1
31	31.0	29.5	35.9/18.0	20.0
32	32.0	28.9	34.6/23.1	21.2
33	33.0	28.2	35.2/24.0	20.5
34	34.1	26.1	31.6/21.6	19.9
35	35.1	26.6	29.6/21.8	19.8
TOTAL ave	24.9	36.1	61.0/14.8	23.0

SURI CURVATURE (AAA)
White by micron
(223 alpacas)

MICRON	CURVATURE	SD CURVE
16/18	20.28	19.2
19/20	18.34	19.3
21/23	16.01	16.28
24/25	15.05	16.2
27/30	14.41	16.5
31/35	11.66	14.2

AVERAGES : CV MICRON & CV CURVE FOR
HUACAYA & SURI WHITE GROUPS

GROUP	MICRON	CV M	CURVE	SD CRV	CV CRV %
HUA	24.9	21.5	36.10	22.96	63.60
SURI	24.31	24.1	15.55	16.56	106.48

Some GENERAL averages from AAA data base (5430 huacayas)

COLOUR	NUMBER HUACAYA	AVERAGE MICRON	AVERAGE CURVATURE
BLACK	795	28.77	26.50
BROWN	938	27.28	31.46
GREY	324	26.76	32.60
FAWN	1755	25.69	35.20
WHITE	1618	25.02	35.97

WHITE BY AGE

AGE	NUMBER HUACAYA	AVERAGE MICRON	AVERAGE CURVATURE
1	473	22.28	37.46
2	406	24.26	36.83
3	263	25.78	35.90
4	182	27.02	34.80
5	106	28.07	34.50
6	62	28.70	32.3
7	36	29.43	31.78
8	33	27.96	33.80
9	35	28.27	33.38
10/12	21	27.83	33.38
TOTAL	1618		

DISCUSSION

STUDY 1

When analysing the 261 alpaca samples it was very evident that the good styled character (1/2 rating) displayed more consistency between the relationships of micron – frequency – curvature. However as a total group, only the micron to curvature showed any reasonable relationship. This trend makes it very hard to confidently assess or estimate characteristics, particularly crimp frequency to micron.

The average micron also increased from the 1 / 2 group (21.15) through 3 / 4 (24.12) to the 5 / 6 group (25.82). Unfortunately ages were not known, as older animals in the lower groups may be an influence. However this may be due to the character becoming more irregular and lacking of definition. This has been shown in past research (merino sheep) to be an influence (Duerden 1927).

Duerden developed a wool appraising system. He matched the Bradford quality count (which was used as an indicator of the processing abilities of the wool), to the wools crimp frequency. He allocated quality numbers to this relationship. He did this research on adult wools and found, whilst assessing the relationship, that the plainer wools (lacking regular character, expression and definition) tended to become coarser in fineness as the character expression diminished.

The first factor, mentioned above, that may affect the consistency of the Alpaca results, is that the samples ranged from an age of 1 year to 5 years (ages were not available). Alpacas are at their finest as a 1 year old, the same as sheep and tend to become stronger with age/body size increase. This is shown in the Study 3 AAA data. Averages (white by age). 1 yr – 22.3u 2 yr – 24.3u 3 yr – 25.8u 4 yr – 27.0u 5 yr – 28.1u.

The relationship for micron and curvature was strongest throughout when compared to the other relationships. The correlation between micron and curvature in the 1/2 group (.81) and in the 5/6 group (.72) was good, compared to the average group (3/4), which displayed a poor correlation (.41). In the 1/6 group (all 261 samples) a reasonably good correlation (.79) for micron to curvature was also evident. The re-appearance of a reasonable correlation in the “poor – inferior” group may reflect sampling from older animals demonstrated by a coarser micron and lower curvature. Results seen by Brown (2005) did not show the consistency of the alpaca study for this relationship (correlation of 0.47).

In the micron to crimp frequency comparison the relationship (1 / 6) was poor to “by chance” (.44) except in the 1/2 group, which displayed a reasonable correlation (.71). The 1 / 2 finding was more consistent than that of Brown (2005) who found an average relationship (.52 correlation) in his stud merino sheep. **This result (1/6) makes it hard to draw a conclusive relationship over the entire alpaca population.**

The curvature to crimp frequency, except for the group 1 / 2, was poor to meaningless. The overall result of .46 correlation was indicative of the influence of the 3 / 4 and 5 / 6 groups (.08 / .03 correlation respectively). However the 1 / 2 group (.77 correlation) was far more consistent. These results were similar to Brown (2005) stud sheep research where he found a correlation also of .77 for the curvature to crimp frequency relationship.

It was surprising to see that there appeared to be no real relationship between the various groups of character and the expression of CV of micron (.17 correlation). The average of each of the groups was all within a maximum variance of 1.39%. The average CV for the 261 samples was 21.36%. No FEM or CEM data was available for all the tests. This made further analysis unavailable.

Curvature and CV of micron showed no strong relationship (#261) as evident by the R2 0.1199 (.35 correlation).

Curvature and character, showed a weak relationship, R2 0.323 (.57correlation), when viewed as the total herd of 261 alpacas.

Coarse micron fleece with high frequency when compared to fine micron fleece with the same frequency tended to have lower curvature readings. This may be due to sample preparation in the laboratories where the 2 mm snippets of coarse microned fibre do not maintain their curvature.

Curvature appeared to be influenced more by **micron** than the frequency and amplitude although the frequency and amplitude did have a varying influence.

When randomly comparing the crimp frequencies of 8, 4 and 6 some interesting observations appeared. These are shown in the chart below.

CRIMP FRQ	MICRON	CURVE	CHARACTER
8	21.4	43.5	2
8	22.7	40.7	2
8	26.4	33.2	3
8	25.3	35.4	3
4	20.5	44	3
4	21.5	42.8	3
4	28.5	27.7	2
4	29.7	28.8	2

It was noticeable within the individual crimp frequency groups of the 261 population (4 – 8 crimps per inch), that there was considerable variation for **micron** as well as for **curvature**. It is well known within the sheep industry that within different genetic strains of sheep each of the crimp frequencies have a range of microns within that group.

COMMENT There is a belief amongst some wool scientists, that is, when the fibres are cut into two mm snippets when preparing for testing, some of the stronger microned fibres do not maintain their curve, but tend to straighten out (changing from their original shape). Hence this may be the reason for the lower curvature reading. This may, along with the various amplitudes, help explain the variation found in curvature for a given crimp frequency. Cortical cell structure may also have an influence. Genetics and age are also involved. ***(this should be investigated further)****.*

STUDY 2

NOTE: Since the tests for this comparison were taken, the AWTA has altered their solution to a "water base". This has altered how their current laser views the curvature (the water based solution relaxes the fibres hence the lower curvature readings). The data in this study was from a LASER SCAN using a 92%Isopropanol – 8% water formula as its liquid medium.
Other laboratories using a Laserscan are most likely to still be using the isopropanol/water formula, as it is believed the AWTA is the only laboratory at this stage to have gone to this water based solution.

Curvature results varied between OFDA and Laser results (Laser reading on average around 17.4 deg mm higher than the OFDA). The correlation between the curvature measured by OFDA and by the Laser is poor, with OFDA measuring significantly lower curvature than Laser over the whole range
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.

Research on stud merino sheep (Brown 2005) also showed variance between both machines. However the comparison was on a Laserscan (AWTA – Water based solution) and OFDA 2000. In this comparison the Laserscan readings were lower than the OFDA due to the Laserscan solution. The Laserscan averaged micron (16.8) and curvature 58.4 to the OFDA, micron (17.2) and curvature (84.7). This was a reversed difference of 26.3 deg. mm. **This still confirms that fleeces should be tested on the same type of machine for consistency.**

In the Laserscan measurements of the 100 alpaca samples the spread was greater than the data from the OFDA (Laser R2 0.18 to OFDA R2 0.51). This was also seen in Brown (2005) where over some 3000 sheep the same trend was evident (Laser R2 0.03 and OFDA R2 0.23).
Some effect on the Laserscan spread (alpaca) may be the number of machines used. Only one OFDA machine was used in the alpaca study 2.

STUDY 3

The following results from the AAA database are of (#1603) white huacaya alpacas. This data was separated from the all inclusive colour results (# 5430). This was done to have similar coloured animals to that in study 1.

The curvature to micron showed R2 (0.5174), and a .72 correlation. This was similar to the 261 alpacas in Study 1, R2 (0.6269), and .79 correlation . This could indicate that the sample population in Study 1 is indicative of the population in Study 3, which was drawn from all over Australia. Study 3 group averaged 24.9 micron with a 36.1 dg.mm average and a CV of curve 63.6%. This is not that different to Study 1 with the 261 total group having a 23.5 micron and 37.15 dg. mm average and a CV of curve 65.4%.
The #5430 alpacas of all colours had an R2 (0.578) with a correlation of .76 for the micron to curvature. This group had averages of 26.3 microns, with a 33.4 dg.mm average and a CV of curve 64.7%.

When comparing the large group of alpacas (1603) curvature AAA data with data of the selected 97 alpacas in study 1 (which had a crimp character rating of 1 – 2), the latter showed a higher curvature reading in general for the above 22 micron groups.

Of interest were the low curvatures on the black coloured samples (# 795) with an average micron 28.77 and a curvature of 26.5 dg. mm compared to the fawn and white (# 1755/# 1618) with a 25.69/25.0 average micron and 35.2/35.97 dg. mm curvature respectively. (Data from the # 5430 population)

Data from 223 white suris. The lower correlation, .57 for curvature is probably due to the mixed fleece styles and ages of the fibre that was tested in this population. Fleece types are not as advanced as the huacayas. The high CV of curve (106.48) would tend to support this assumption when compared to the huacaya with a CV of curve (63.7). Suri curvature over the 223 alpacas ranged from 9.8 dg mm to 25.9 dg mm. The average micron for the suri (24.3) was similar to that of the huacaya (24.9).

It was interesting to note that the increase in micron seen as the animal became older, shown in the AAA data, was similar in trend to that found by Holt (2001) from data collected in 1999.

CONCLUSIONS

The results from the well charactered group (1/2) were far more consistent in their relationships for the categories. It is also fair to conclude that if growers breed well defined crimped (good/excellent character) fibre their consistency of evaluation would be more correct. This consistency in the fibre would also enhance yarn performance and fabric construction.

The results indicate that there is significant variation in the crimp frequency and micron diameter relationships. Crimp frequency is not a reliable indicator of micron. However in very well crimped fibre some consistency is evident.

Micron influenced curvature more than the frequency and amplitude although the frequency and amplitude did have a varying effect.

In the good-charactered group a meaningful relationship is shown between curvature and crimp frequency.

Curvature and CV of micron showed no strong relationship.

Curvature and character, showed a weak relationship

A poor relationship was shown between character and CV of curvature.

A common average result was: 24/25 microns with a 35/36 dg mm curvature.

Meaningful comparisons of **fibre curvature** between different fleeces can only be made if measured by the same techniques.

From the AAA data coloured fibre was coarser in micron and lower in curvature relatively in shade compared to the white fibre.

ESTIMATED VALUES

Using information gained from all studies some estimated values were created.
These values are consistent with those in the Regression relationships (see study 1 results), and are estimated qualitatively from a broader range of data.

The Alpaca chart below are <u>estimated relationships only</u> for crimp frequency, curvature and micron (based on **good / average crimp definition and better: I – 3 appraisal**). These are based on general data in studies conducted by the writer in 1994,2004 2005 as well as data from AAA & Grupo Inca 2004. I would expect these estimates to become more accurate in time, as the alpaca herd in Australasia, Northern America and Britain become more consistent
<u>A bias was made in this chart towards the better-crimped fibre.</u>

NUMBER OF CRIMPS PER INCH	FIBRE CURVATURE (DEG mm)	MICRON (approx)
11/12	60/55	13/14
10	54/51	15/16
9	50/47	17/18
8	46/44	19/20
7	43/41	20/21
6	40//38	22/23
5	37/36	24
4	35/33	25/26
3	32/29	27/28
2	28/25	29/31

RECOMMENDATIONS

A fully controlled research project to be carried out using 1000 huacayas and 500 suris that are selected for their fibre types, micron, age, frequencies/lock type, length, genetics etc. This would give a more accurate indication of the genetic variance between animals and how they express their micron, crimp frequency (hua) and definition of character/style.

ACKNOWLEDGEMENTS

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Special thanks to Dr Jim Watts for his review and advice on this study, also to Dr Paul Swan (Paul Swan & ass), Dr Daniel Brown (UNE) and Dr David Crowe (AWTA) for technical advice.

Special thanks to Mr Mike Safley & Australian Alpaca Ass for their contribution and support as well as the alpaca breeders from USA & AUSTRALIA, who provided fleece for this study.

REFERENCES

Duerden, J.E. **"Standards of thickness and crimps in Merino grease wools"** Journal of the Textile Institute (1929)

Brown, D. **"Novel Merino Wool Quality Traits-Pilot Project"** (AWI – EC814) AGBU (NSW DPI – UNE) (2005)

Holt, C. & Scott, S, **"A Survey of Suri Fleece Characteristics"**, Report for Suri Breeders Network AAA Melbourne Institute of Textiles (1998)

Holt, C. **"Statistically Speaking"** AAA 2001 Alpaca magazine

FURTHER READING

Baxter, B.P. **"Preliminary Investigations into the use of OFDA for Estimating Bulk",** International Wool Textile Organization, Cape town Meeting 1996.

Fish, V.E.. **"Measuring Fibre Curvature: Key Issues",** Wool Technology and Sheep Breeding, 2002

Fish, V.E., Mahar, T.J., Crook, B.J. **"The Influence of Preparation Techniques on Measurement of Fibre Curvature"** International Wool Textile Organization, Report No: CTF06, Christchurch meeting, April/May , 2000.

McColl, A., Lupton, C., Stobart, B. **"Fiber Characteristics of US Huacaya Alpacas",** Alpaca Magazine – Summer 2004

Smuts, S., Schieth, A., Hunter, L. **"OFDA Measurement of Wool Fibre Crimp – A Preliminary Report",** CSIRO Division of Textile Technology, South Afric

Swan, P.G., Mahar, T.J. **"An Objective Technique for Measurement of Fibre Crimp Curvature"** International Wool Textile Organization, Report No: 18,Dresden meeting, June, 1998.

Swan, P.G. **"Measurement of Wool Fibre Curvature", Swan & Ass** Private Publicatio

Swan, P.G. **"Introducing Fibre Curvature", Swan & Ass** Private Publication

Swan, P.G. **"Objective Measurement of Fibre Crimp Curvature and the Bulk Compressional Properties of Australian Wools",** University of New South Wales, Sydney, 1993.

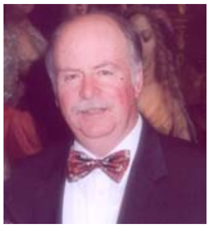
Tang, L., Crowe, D.W. **"Measurement of Staple Crimp Frequency"** Report CTFO1 IWTO Istanbul Meeting November 2003

Xungai Wang, :ijing Wang, Xin Liu and Huimin Wang "**The Softness of Alpaca Fibres",** Australian Alpaca Association

Xungai Wang, :ijing Wang, Xin Liu and Huimin Wang **"Resistance to Compression Behavior of Alpaca Wool",** Deakin University Geelong 2004

***NOTE:* The study remains the intellectual property of Cameron Holt**

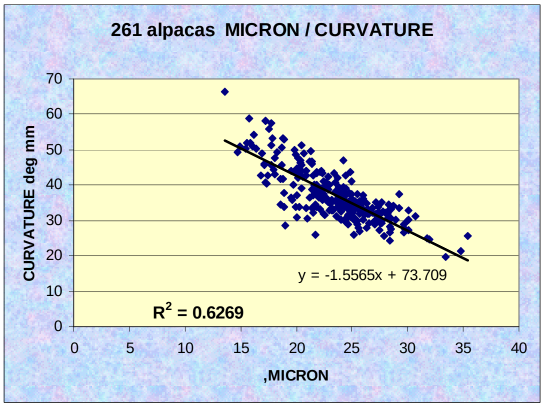
AUTHOR

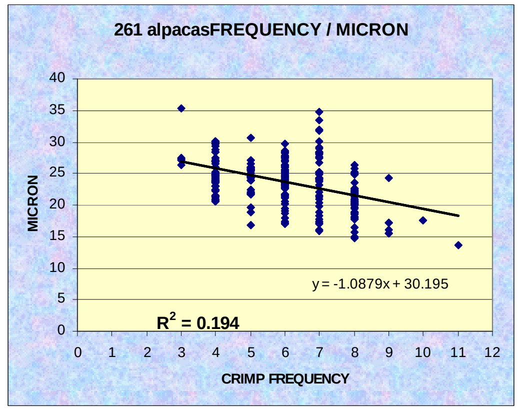


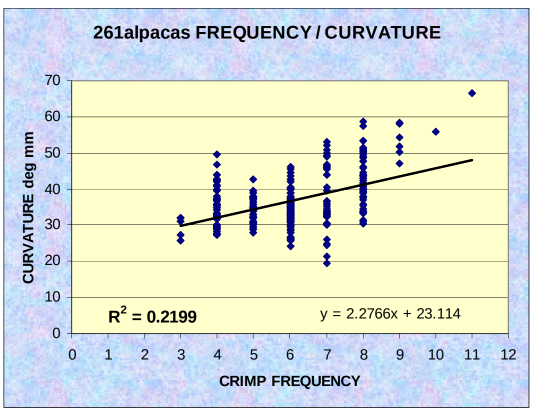
CAMERON HOLT

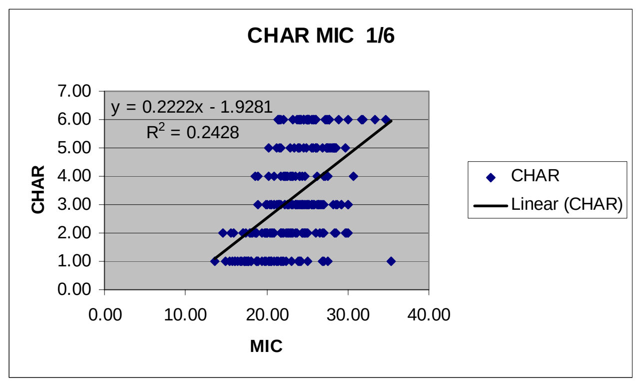
Cameron, who has had some 40 years in the fibre industry as a wool broker, judge, educator and also in his semi retirement continues with alpaca research. He is currently judging for the Australian Alpaca Association and in his role as Senior Fleece Judge and trainer for AOBA, has been involved in the training of their judges as well as judging. Cameron, a leading alpaca fibre expert, continues his educational clinics and lectures throughout the world.

GRAPHS #261 1/6









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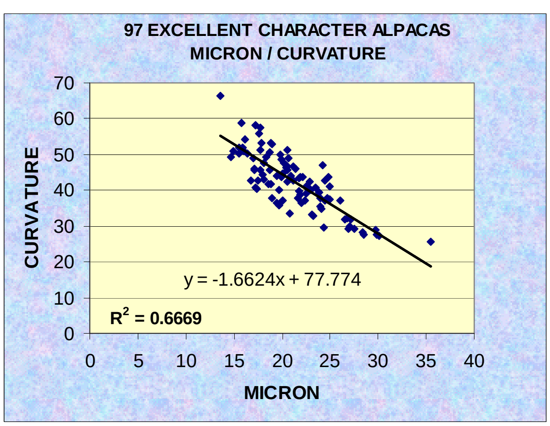
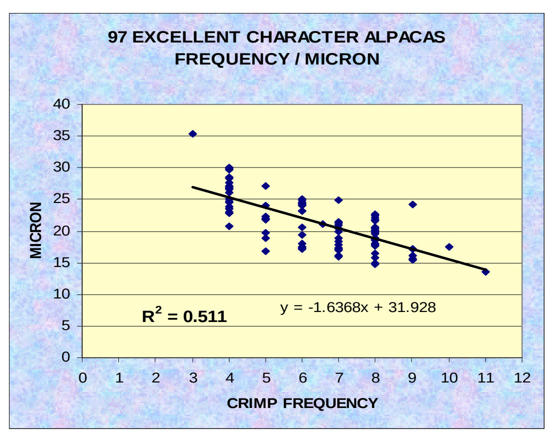
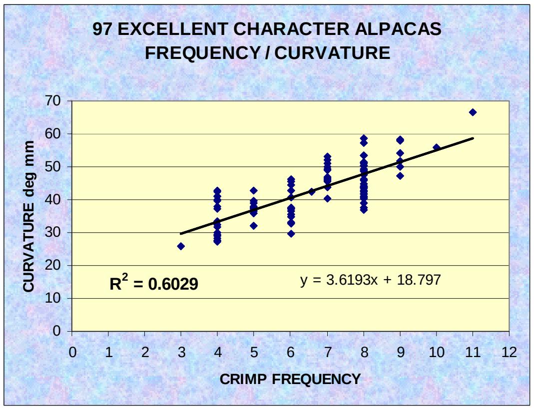
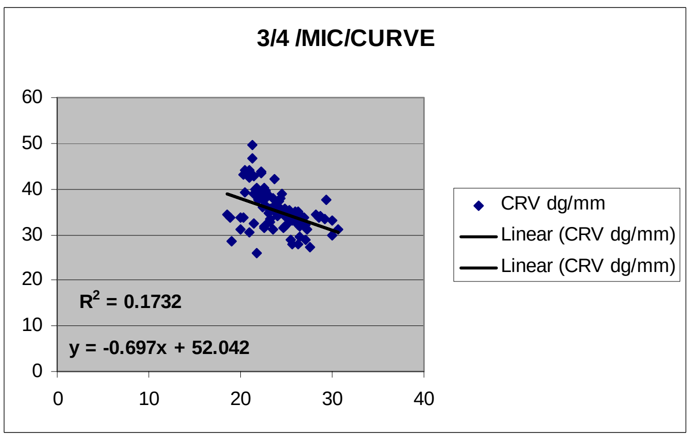
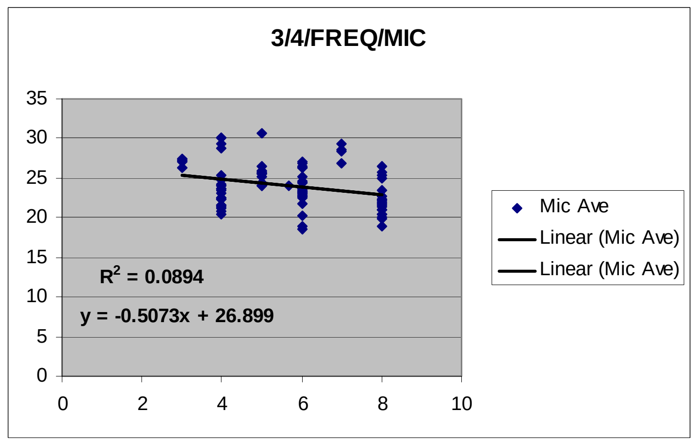


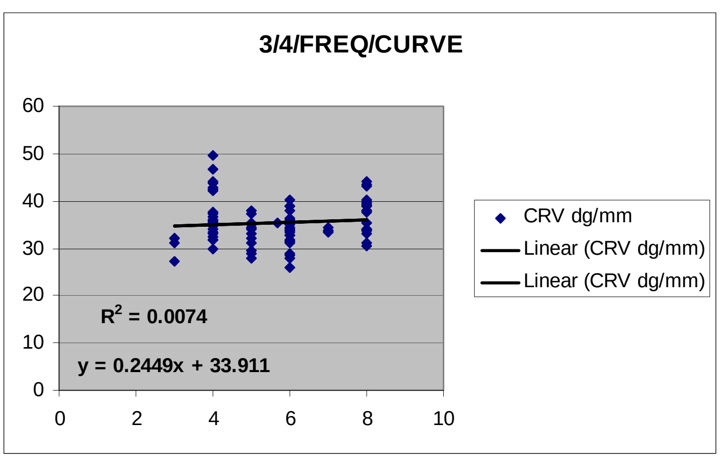



97 EXCELLENT CHARACTER ALPACAS
FREQUENCY / CURVATURE
CURVATURE deg mm
CRIMP FREQUENCY
R^2 = 0.6029
y = 3.6193x + 18.797

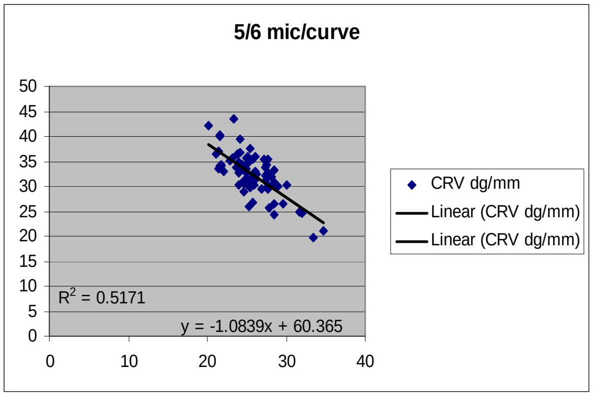
#88 3/4

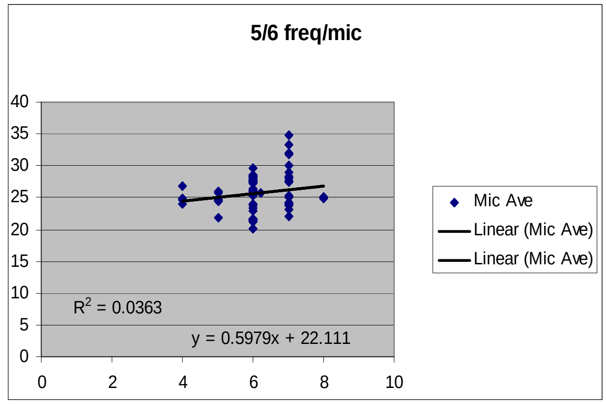

3/4 /MIC/CURVE
CRV dg/mm
Linear (CRV dg/mm)
Linear (CRV dg/mm)
R^2 = 0.1732
y = -0.697x + 52.042

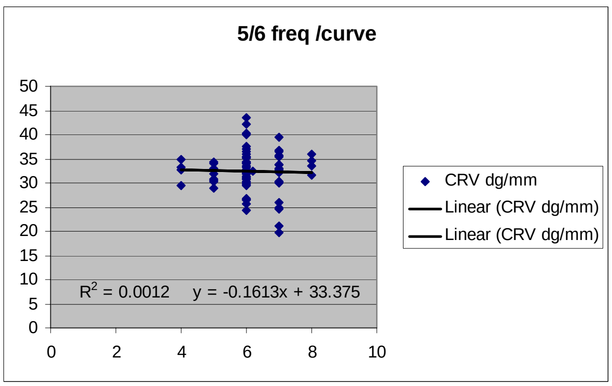

3/4/FREQ/MIC
Mic Ave
Linear (Mic Ave)
Linear (Mic Ave)
R^2 = 0.0894
y = -0.5073x + 26.899

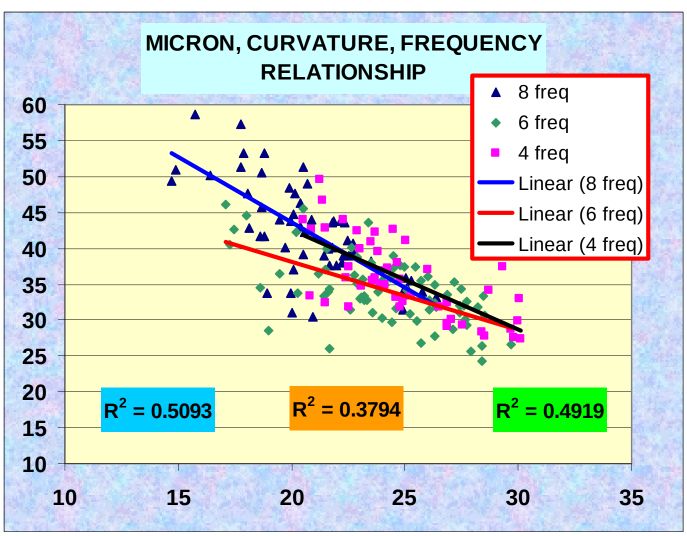

3/4/FREQ/CURVE
CRV dg/mm
Linear (CRV dg/mm)
Linear (CRV dg/mm)
R^2 = 0.0074
y = 0.2449x + 33.911

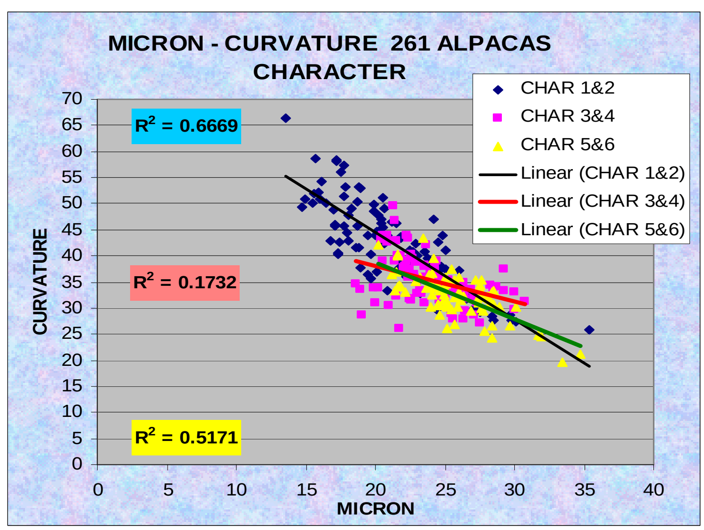
#76 5/6

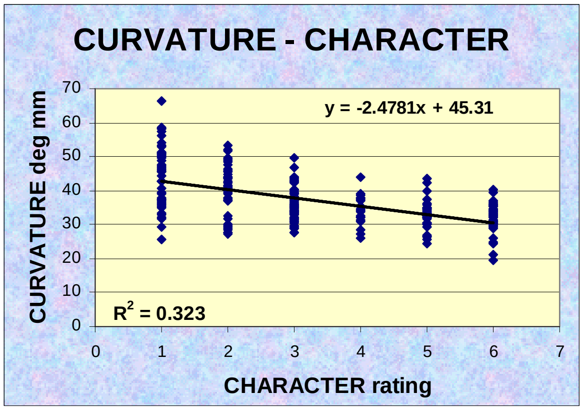

5/6 mic/curve
CRV dg/mm
Linear (CRV dg/mm)
Linear (CRV dg/mm)
R² = 0.5171
y = -1.0839x + 60.365

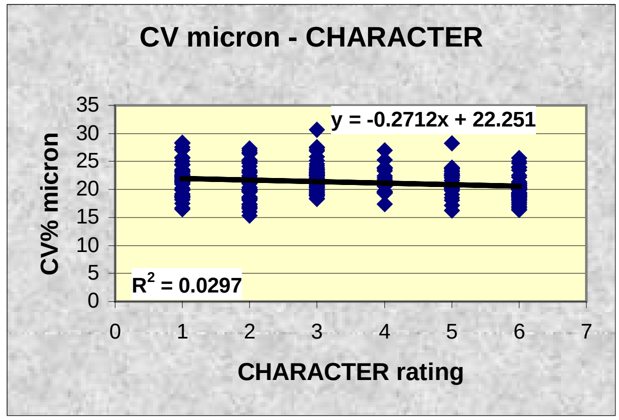

5/6 freq/mic
Mic Ave
Linear (Mic Ave)
Linear (Mic Ave)
R² = 0.0363
y = 0.5979x + 22.111


5/6 freq /curve
CRV dg/mm
Linear (CRV dg/mm)
Linear (CRV dg/mm)
R² = 0.0012
y = -0.1613x + 33.375

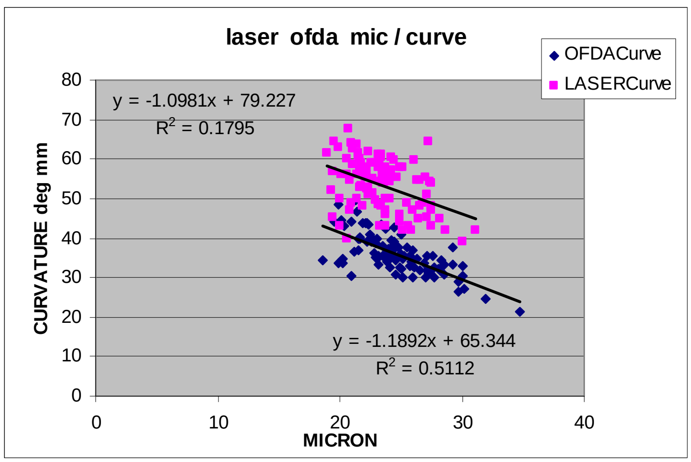

MICRON, CURVATURE, FREQUENCY RELATIONSHIP
8 freq
6 freq
4 freq
Linear (8 freq)
Linear (6 freq)
Linear (4 freq)
R² = 0.5093
R² = 0.3794
R² = 0.4919

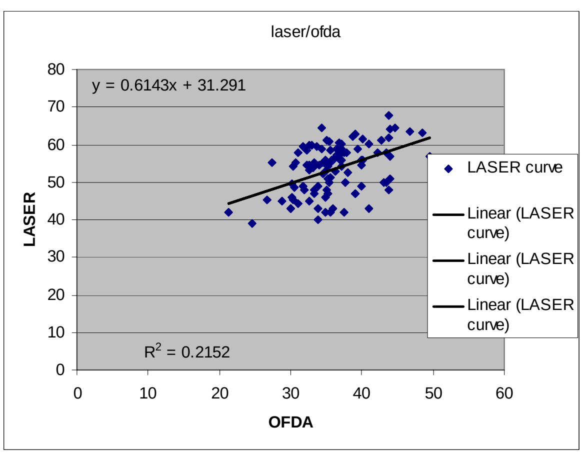

MICRON - CURVATURE 261 ALPACAS CHARACTER
CHAR 1&2
CHAR 3&4
CHAR 5&6
Linear (CHAR 1&2)
Linear (CHAR 3&4)
Linear (CHAR 5&6)
R² = 0.6669
R² = 0.1732
R² = 0.5171
CURVATURE
MICRON

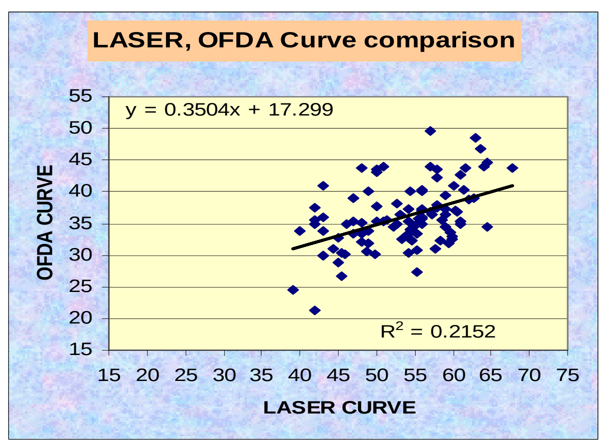




STUDY 2 GRAPHS







STUDY 3

GRAPHS