

FIBRE METROLOGY - 1

BREEDER FIBRE SAMPLING By Cameron Holt ©Jan2017

EXTRACTS from CH4 "A DEFINITAVE GUIDE TO ALPACA FIBRE"

To increase production of clean fibre per head Alpaca growers need to use measurement so as to select the animals with the desired characteristics, which will give them increases in that particular area. The most accurate method is by using scientific equipment at a testing laboratory.

The measurements or samples below can be taken easily by the breeder, and where necessary tests carried out by a testing house.

Fleece Sample Taken by Breeder	Responsible for test	
Total Fleece Weight	Breeder	Kg
Yield (Washing)	Test lab	X%
Diameter of Fibre	Test lab	Micron
Length of Fibre	Breeder/Test lab	CMS
Fibre Curvature	Test lab	DEG mm
Prickle Factor (comfort factor)	Test lab	% >30μ (% ≤ 30μ)
Medullation	Test lab	X %
Live Weight	Breeder	Kg
C of V	Test lab	X%
SD	Test lab	1 St Dev

Other tests which could be carried out within a stud flock with assistance are:

Primary Fibre micron
Secondary Fibre micron
S/P Ratio
Follicle Density

These tests could be of benefit for well-established studs.

NOTE: The correctness of any test result depends on the accuracy of the sample taken.

Most of the Australian sheep's' wool offered for sale today is tested before sale. Processors demand accuracy and precision in the testing of fibre so that they can correctly batch (match) and blend the fibre to produce a yarn of a given specification.

The testing technique used by the wool industry is mostly the Laserscan & and sometimes the OFDA100.

Almost all alpaca fibre tests currently performed from grower samples are called "Guidance Tests", because the results are not certified. (see later)

Before looking at sampling and measurement it is important to understand 3 basic concepts which could have a large affect on the outcome of your test results.

1. PRECISION

The ability to provide a test result that is repeatable (using the same sampling technique and testing machine would help achieve this).

2. ACCURACY

(a) The ability of the sample to correctly represent the true (correct) value of the fibre to be measured. A full grid sample (see later) of the fleece (not a few sites) or a coring of the whole fleece would enable a more accurate value to be assessed from the "Breeders" sample point of view.

(b) The ability of the testing machines to correctly interpret and calculate the true values of fibre being measures. (This would include controlled **standard laboratory conditions**, 20degrees C [+ -2 degrees] and 65% humidity [+ - 2%], as well as correctly controlled sub-sampling of the "Breeders sample" according to IWTO testing procedures).

3. BIAS

Most samples taken for alpaca (animal / fleece) evaluation are biased as per the definitions (see below, sampling methods and techniques).

FOR A RESULT TO BE ACCURATE IT SHOULD BE PRECISE AND FREE FROM BIAS.

REMEMBER

For practical purposes of comparisons within your alpaca herd it is important to (as mentioned earlier) use the same sampling technique and the same testing laboratory / machine so as to cut down the variance that can occur between testing results.

SAMPLING

Whenever any testing is carried out, whether for fibre fineness, yield, or perhaps vegetable matter content, the item requiring measuring (e.g.: bale or fleece) cannot be tested completely. Complete testing of all fibre cannot be carried out because the test is destructive, and no fibre would be left for processing. A sample is therefore taken from the population and this representative sample is tested.

SAMPLING METHODS & TECHNIQUES

Scott (1981) says that to sample a fleece, a bag, a bale or herd of Alpaca's or any population at all, the sample taken must fulfil 2 basic requirements.

1. Every fibre has a chance of being selected.
2. The method should not be intentionally or unintentionally manipulated in order to obtain a biased sample.

Bias occurs in the following ways:

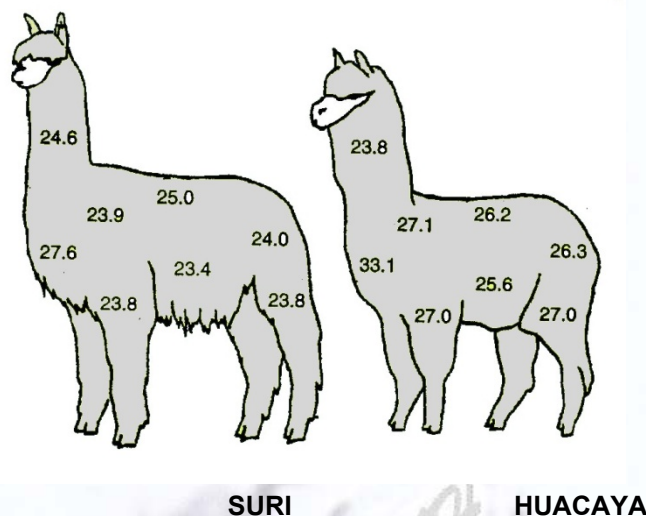
1. If the property of the lot varies from place to place and the sample drawn from only one or two places, the sample is likely to be biased (technically this applies to "site" sampling).
2. Nearly all methods depending on personal selection of fibres lead to biased samples.

Bias, which contributes to "sampling error", may give a lower/higher result. Therefore to acquire an accurate result the sample should be free of bias. Site samples are by definition a "Biased sample".

SAMPLING INDIVIDUAL ANIMALS

The Alpaca does vary for fibre diameter from neck to the britch:

Within each breed of Alpacas there is a variation between sites on the individual breed, but there was no significant variability between the Suri and Huacaya in variability between sites. (Holt/Scott 1998)



This would suggest that the most accurate form of fibre measurement would be by gridding the fleece area. Research (Holt/Stapleton 1993) done on variation of Alpaca Huacaya fleece has shown that animals vary in evenness, that is, some display a more even fleece (fineness) to that of others. Studies on Suri fleece (Holt/Scott 1998) have shown similar results. This variation may cause problems when comparing one animal with another.

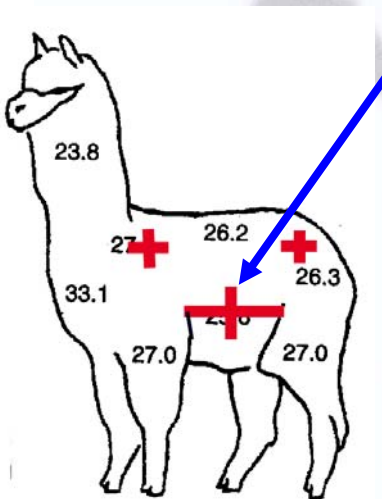
When testing with site measurements for micron and/or yield they should **be used only as a guide** and/or ranking for that animal within your herd. It also can be used to monitor the fibre change in micron from year to year. The full fleece test takes into account micron variation over the fleece (C or V) and should be read in conjunction with the Histogram print out.

MIDSIDE SAMPLE

A sample is drawn from the mid side as shown (a). This sample (although scientifically biased) as mentioned early may be a reasonable representative of the total fleece (Holt/Stapleton 1993). Care must be taken on site selection as sampling too high or too low may give a finer or stronger result.

Site sampling can also be carried out using the shoulder pin and hind pin in conjunction with the midside.

These will give an indication of variance over the animal. A more accurate measurement would be to send the whole fleece for assessment or grid the fleece. This may only be practical for the top animals. (See below)



(a) Midside

(A three site position sample can also be used for fleece variance)

NOTE A word of caution. When taking a midside or site sample from an animal, you must cut the sample at skin level. If you vary the level of the plain of the cut between your samples then the cut would represent different growth patterns (nutritional and health as well as possibly age). This would make comparisons amongst animals unreliable.

The sample must be:

- (a) Carefully and Accurately Identified
- (b) Securely packaged for dispatch to a Testing House.

Mid side sampling can also take place during shearing. Sampling taken at this stage can complement fleece weighing, which is done at this point of time. The same procedures for testing would apply.

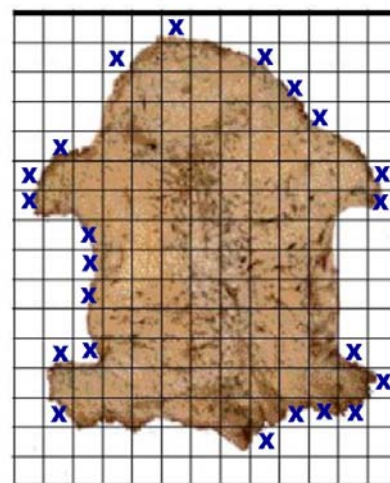
Studies into site variation (Holt/Stapleton 1993) gave impressions that the Shoulder pin-bone and Mid were more reliable than those of the Hind pin-bone for fibre diameter measurements.

A reliable method for obtaining a representative sample from an Alpaca fleece is the



Grid sampling technique.

GRID SAMPLE



"X" DO NOT SAMPLE FROM SQUARES THAT ARE LESS THAN 1/2 FULL

This occurs as follows:

(a)	Spread the alpaca fleece evenly on a table.
(b)	A grid made of a mesh approximately 4" 4" (100 x 100) is placed over the whole fleece.
(c)	A sample (eg 1 staple) is taken from each square filled with fibre.
(d)	All squares more than half-filled with fibre are sampled, those with less rejected.
(e)	The small sample taken is in turn put together with the others taken from the same fleece to form a composite sample.
(f)	The sample is carefully and accurately identified.
(g)	The sample is securely packaged for dispatch to a testing house.

For “grid samples”, advise the Testing Laboratory that they are “grids” as they need to be sub-sampled using the “mini – core machine or similar. The whole sample is cored to avoid bias in the result.

All testing must be put into context. Research by Holt and Stapleton 1993 showed that fleece from a group of huacaya alpaca's, indicated an average difference of .77 microns between the grid sample (**unskirted fleece**) and the midside sample (**on animal**). The mean magnitude of difference was .92 microns. These indicated a correlation between the two sites of .93.

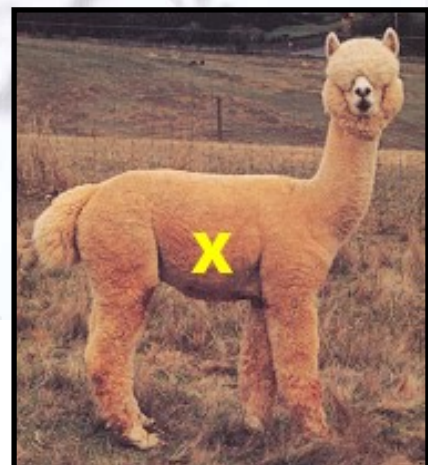
Later research in 2004 by Davison and Holt on a number of huacaya fleece, where comparisons were made between a grid sample (**skirted fleece**) and a midside sample (**on animal**), showed an average difference of .4 microns with a mean magnitude of difference of .87. This was the equivalent of a correlation of .94. Breeders must remember that on some alpacas, the fleece does vary considerably.

Test results (based on research from Holt / Stapleton 1993) indicated an average variance (over the research huacaya fleece) of 4.8 microns excluding apron and 11 microns including apron. Research in 1997 by Holt / Scott on suris fleece indicated an average range of 3.2 microns (**excluding apron**) and 10.1 microns (**including apron**) over the tested Suri herd.

The following photos demonstrate the need for care when sampling your alpaca.

The alpaca in photo "1"

has a reasonable even fleece all over. Here sampling on the midside may be adequate for your needs.





The animal in photo "2"



shows extreme guard hair. This is seen in the hairy appearance. Midside sampling on an animal like this may give you an inaccurate result.

NOTE However, "The midside is likely to be more accurate on this alpaca than any result sampled from other single sites".

This type of alpaca should be grid sampled.

As mentioned earlier grid sampling is a more accurate form of measurement than any form of site measurement.

FIBRE MEASUREMENT

FLEECE WEIGHING

The selection of animals on your eye assessment for clean fleece weight or yield is not accurate.

The process of fleece weighing is a way to overcome these problems and give a more accurate measurement of fleece weight and in turn yield.

The weighing takes place in conjunction with mid side sampling or grid sampling during the shearing process, or a similar time each year.

Make sure your scales are accurate and weigh in 1.75 oz (50 grams) increments.

The procedure is as follows:

- (A) As the mid side is shorn a small sample (50x50mm) is taken - a tag with the alpaca's number is put with the sample.
- (B) The fleece is laid on a table and if a grid sample is required, then the sample is taken as previously mentioned.
- (C) The total fleece plus sample is weighed together, and weight recorded against the alpaca's number in your record book or card.

NOTE: Information re fleece colour/type etc can also be noted at this stage.

- (D) The sample is carefully and accurately identified, and placed to one side.
- (E) The fleece is then placed in the appropriate fleece type.
- (F) When all sampling is complete the individual samples are packaged and sent to an approved testing house.

An important point is that all Alpaca's should be tagged for identification and that the scales used are calibrated.

It is advisable to test when the animal has a full year's production.

YIELD

Fleece obtained from Alpacas contains various impurities, that is, natural and acquired impurities (grease, vegetable matter, dust). The sample taken for micron testing, is used by the testing lab to calculate yield.

Alpaca fibre also contains an undesirable medullated fibre (GUARD HAIR).

Heavy guard hair in Alpaca fibre is not desirable and therefore should be considered in calculating yield.

Yield is expressed as a percentage of the greasy (Raw) sample or fleece.

When tests are complete the possible information supplied will give:

(a) Yield	Total Fleece Weight Yield % Clean Fleece Weight
(b) Fibre Diameter	Mean Fibre Diameter Standard Deviation Co-efficient of Variation Spinning fineness Fibre curvature

Medullation can also be measured if required (white only) on the O.F.D.A. 100

TESTING FOR WASHING YIELD

Yield	Amount of useable fibre present in a given amount of greasy fibre.
Washing Yield	Percentage of clean scoured fibre and vegetable matter at 16% regain (moisture allowance).
Testing Method	The greasy sample is weighed accurately then WASHED.

After the sample has been thoroughly washed it is dried so that no moisture remains. The sample is then said to be "**BONE**" or "**OVEN DRY**".

The sample is then REWEIGHED and an **OVEN DRY WEIGHT** is recorded.

Once oven dry weight is known, **WASHING YIELD** can be calculated.

$$WY = \frac{\text{Scoured Oven Dry WT} + 16\% \times \frac{100}{1}}{\text{Greasy Weight}}$$

Example:

Greasy WT	=	125 grams
Scoured ODW	=	100 grams
Standard Regain	=	16%

$$\begin{aligned}
 WY &= \frac{100 + 16\%}{125} \times \frac{100}{1} \\
 &= \frac{116}{125} \times \frac{100}{1} \\
 &= \frac{11600}{125} \\
 &= 92.8\%
 \end{aligned}$$

NOTE:

Washing yield does not take into account vegetable matter as this is not removed during the scouring process; and is therefore part of the yield. Where you are ranking animals with similar V.M. content this would not be of concern: Most mid side samples and skirted fleece grid samples have minimal V.M. present.

Remember: Any test is only as good as the machinery used and the *Method of Sampling.*

Care when referring to percentages as we are interested in total clean fleece production not how high the yield % is or how high the greasy fleece weight is:

BREEDERS

It should be noted by 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 Most Grid samples, as shown earlier, at this stage are not being core tested when using the OFDA 2000 method (unless they have an OFDA 100 (snippet), adaption).
- 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. Current trials are being carried out to get uniform results.
- 4 Testing operators do not always use the same "lab sub-sampling" procedures, hence adding to the possibility of "sampling error" and variances' in results.
- 5 Testing machines not calibrated to the IWTO testing standards will likely give varying results between the different calibrations currently being used today; December 2016.

TESTING FIBRE CHARACTERISTICS

As mentioned we can measure "FLEECE" for many alpaca characteristics such as -

- micron
- c of v
- sd
- fleece weight
- yield
- length
- strength
- crimp
- fibre curvature
- follicle structure
- medullation
- bulk

Micron is considered to be the most important characteristic for measurement. Fibre diameter is the single most important characteristic/property for all fibre. It accounts for 75/80% of value in the processed "Top" (Bell-Ainsworth 1984).

Measurements are generally carried out on two machines. The **Optical Fibre Diameter Analyser (OFDA) and the Laser scan**. Regardless of what method is used, an understanding of some statistical terms is necessary.

TERMS

MODE: The most commonly occurring value. (The highest peak or the micron with the greatest number of fibres recorded against it).

MEAN: The average of those values (MEAN MICRON).

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, however the height and base can vary.

MEAN FIBRE DIAMETER

This is a measure of central tendency and gives mean (average) of the fibre diameter in the sample expressed in microns. One micron is one millionth of a metre.

STANDARD DEVIATION (SD)

This indicates how the fibre diameter in the sample vary around the mean. The smaller the standard deviation the less the variation around the mean.

One standard deviation (+1, -1 either side of the mean), will represent 68% of the fibres measured e.g. given

Mean 26 microns
SD 6.0 microns

then 68% of the fibres will occur between 20 and 32

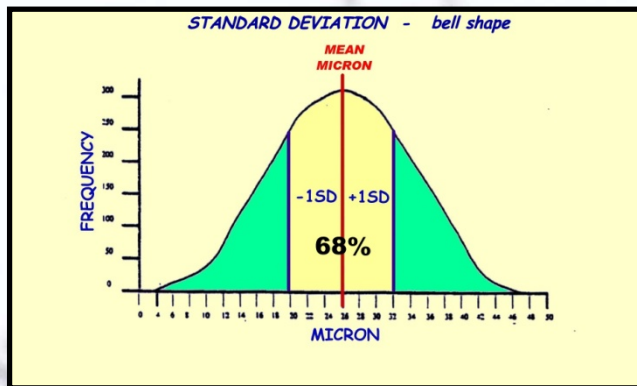
2 SD will represent 95% of the fibres measured (95% of the fibres will occur between 14 and 38)

SKEWNESS is a measure of symmetry, or more precisely, the lack of symmetry. A distribution, or data set, is symmetric if it looks the same to the left and right of the centre point.

“The concept of SD assumes that the fibre diameter is normal (bell shaped)”

(Summerville AWTA 2000).

This normal curve (frequency distribution) is a theoretical curve and 50% of the measurements fall either side of both the “mode” and “mean” that have both the same reading.



Normal Alpaca distribution of measurement curves, as mentioned above, are very rarely seen (if not at all)

CO EFFICIENT OF VARIATION (COV) Is the percentage of variation in the measurements and is related to the mean and standard deviation. The C.O.V. enables various populations to be compared to each other.

Both SD and CV measure the degree of variation of micron in the tested sample.

NOTE; When only "CV" or "SD" is supplied on its own in a test result, you can calculate with the aid of the micron, the missing result.

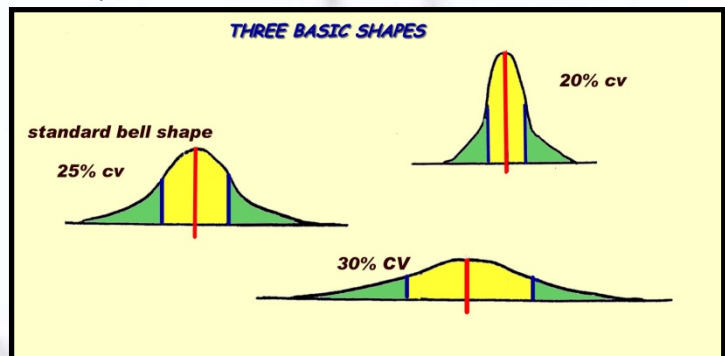
<p>THE FORMULA FOR CV% IS</p> $\frac{SD}{MICRON} \times 100 = CV\%$	<p>THE FORMULA FOR SD% IS</p> $\frac{CV\% \times MICRON}{1} = SD$
----------------------------------------------------------------------------	--------------------------------------------------------------------------

The following table represents 25% CV for each micron. The equivalent SD calculation is next to the listed microns.

MICRON	SD	MICRON	SD
17	4.25	24	6.00
18	4.50	25	6.25
19	4.75	26	6.50
20	5.00	27	6.75
21	5.25	28	7.00
22	5.50	29	7.25
23	5.75	30	7.5

KURTOSIS is a measure of whether the data are peaked or flat relative to a normal distribution. That is, data sets with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly, and have heavy tails.

There are three basic shapes of the normal (theoretical) curve. Only the height (kurtosis) has changed

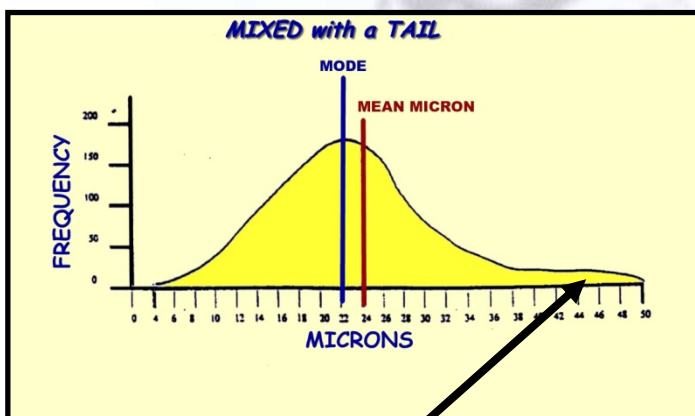


All these have an even spread around the mean but No. 1 is very even and would have a low COV e.g. 20%

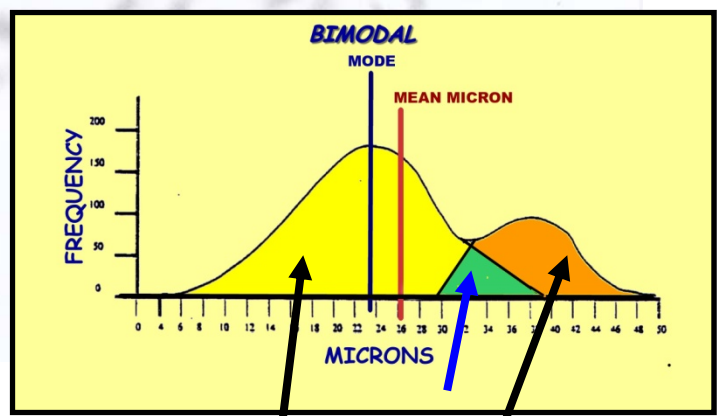
No. 2 is a normal distribution and would have a COV around 25% and No. 3 would be considered to be a mixed histogram with a COV around 30+%.

There are other histogram shapes we see when testing Alpaca fibre.

- A. MIXED WITH TAIL: usually the most common.
- B. BIMODAL: Two different types of fibre, sometimes found in Llama/Alpaca cross.



COARSE FIBRE



P1 (SHARED) P2
TWO POPULATIONS

The fineness of fibre you are breeding in your herd must be considered if you reflect on what the end product that the fibre is to be used for. Breeders should be aware of the average micron of each animal in their herd not only to identify those finer or superior types, but those that are undesirable for the owners breeding goals. The fineness of the micron will determine the final use of the fibre and in some cases how the fibre is to be processed, that is whether the Alpaca is to be blended with another fibre e.g. wool or processed by on its own.

The normal measurement for micron is usually measured on 12 months fleece or thereabouts. I would advise that testing for micron is done at yearly intervals up to 5 years of age (animal's micron goes out for 3 to 5 years on average).

AUTHORS IMPORTANT NOTE TO BREEDERS

Testing Laboratories and / or operators only test what you give them. You get it wrong in your sampling procedure, then so do they. Make sure you know the right method and way to collect your sample for sending to a Laboratory and / or operator.

Any sample being sent for testing, to any test house and being tested by any method, should clearly identify whether it is a **midside or grid sample**.

Testing operators do not always use the same "lab sub-sampling" procedures, hence adding to the possibility of "sampling error" and variances' in results. This can lead to a small differences between results. In summary we can have;

- Variation between Grower samples
- Variation between Laboratory sub sampling of Grower samples
- Variation between machine types
- Variation between machines of the same type

Breeders should select and stick with one or other of the OFDA or laser formats to get uniform results.

Breeders should be aware that Grid samples can have a higher C of V if the animal varies over the body. A single site in general, should be more even (mid side) therefore having a lower C of V than the grid. The laboratory test method of a single cut per staple, "**butt-cut**" (as frequently used in USA), gives an average around 2% lower C of V than the single site sample.

Testing machines not calibrated to the IWTO testing standards will likely give varying results between the different calibrations currently being used today; December 2016.

DO not forget to cut sample at skin level for consistency of results.

Breeders, who wish to fully understand the principles and methods of sampling and testing fleece from the alpaca animal or from the skirted fleece on the table,

Refer to;

"A Definitive Guide to Alpaca Fibre"
Chapter 4, FIBRE METROLOGY page 32 onwards

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The author has made every effort to ensure that the information in this document was correct at time of printing. The information is meant to supplement, the readers own education and experience. The author advises readers to take full responsibility for their decisions related to alpaca fibre / animals contained within.

It is important to understand the large variance still in the alpaca gene pool, as research results quoted in this article with another research group of alpacas, the findings may vary slightly to those results indicated herein.

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Cameron Holt, a leading international alpaca fibre expert has had some 50 years in the fibre industry with 25 of those later years dedicated to alpaca research and education.

His numerous research programs and publications over these years helped enable this book to be written.

