The Alpaca Breeder's Quest for "True" SD

Paul Vallely, Australian Alpaca Fibre Testing
Jennifer Errey BSc Hons**, Errydge Park Alpacas**

Using Standard Deviation (SD) of Fibre Diameter has proven to be a useful objective trait for alpaca breeders in their quest for genetic improvement towards producing high quality fleeces. It is a standard statistical result included in any fibre testing report and thus easily obtained by all alpaca breeders interested in the fibre production qualities of their stock.

What is SD?
We measure the Micron (or average fibre diameter – AFD) with our fleece sample testing. However, just as not all full grown alpacas are exactly the same size, so the fibres growing within their fleece are not all exactly the same fibre diameter. SD is a statistically calculated measure of the variability between the individual fibre diameters produced by an alpaca. SD, as calculated for fibre testing results, varies depending on 2 factors:

- hereditary (or genetic) influences
- environmental (or stressor) influences

Alpacas that exhibit low SD's are typically alpacas with low incidence of coarse fibres and low variation in fibre diameter Micron across the fleece. These fleeces exhibit superior fibre processing outcomes. SD is one of the most heritable fleece traits and, therefore, presents clear advantages for inclusion as a breed selection trait. To cap it off, as the alpaca industry moves towards a more commercial fibre production basis, SD is a key selection criteria for fibre processing buyers and thus critical when considering the qualities of potential/active stud sires.

A review of annual statistics of fleece testing performed by Australian Alpaca Fibre Testing (AAFT) for the calendar year 2014 reveals the average SD for huacayas is about 4.7µ, while the average SD for suris is about 5.2µ. While some breeders have enjoyed considerable improvement over the years in their SD's as a result of carefully planned genetic improvement strategies, the national annual averages for SD have generally remained constant for the past 5 years. That was until the 2013/2014 season.

For Australia, 2013/2014 was the type of growing season that producers of natural fibre dread. Spring (Sept to Nov 2013), turned out to be the equal hottest on record while the national rainfall was 34% below average. Whilst the northern tropics enjoyed their usual wet season drenching, in the southern states, there were only about 15 previous springs in the past 115 years that were dryer. As spring holds the key to summer feed conditions throughout southern and eastern Australia, it was inevitable that much of Australia was going to be a 'very sunburnt country' for the first part of the fibre growing season (spring shearing until the following shearing) ie. spring, summer and early autumn.

Then in April 2014, came rain, rain – and more rain for the south. The southern country was drenched with many areas experiencing 40% more rainfall than the national average. South Australia had its second wettest April and many other parts of the country almost broke records. Suddenly the sunburnt country turned into lush paradise for livestock (and internal parasites as many soon realised).

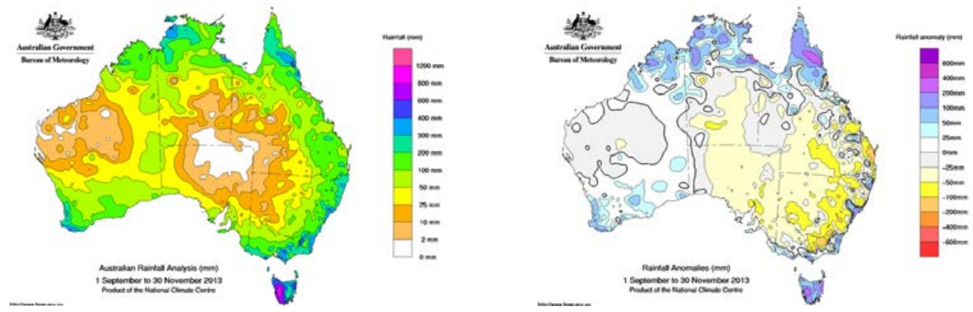

Figure 1: Rainfall mm: Spring (Sept 2013-Nov 2013) and average anomaly

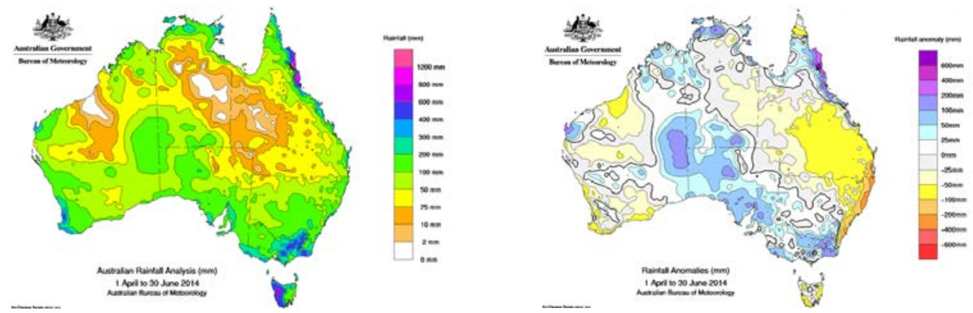

Figure 2: Rainfall mm: Autumn (April 2014-June 2014) and average anomaly

Rainfall data depicted above (courtesy BOM website) shows the stark contrast between the Spring 2013 and Autumn 2014 rainfall in the southern Australian area, particularly in the North Eastern Victoria and Southern NSW region. In Spring the rainfall was up to 200mm below the average for the 3 months. In Autumn, the rainfall was up to 200mm above the average for the period. If average 6 month data period were taken for the rainfall anomaly, it would appear to be a quite normal unexceptional period rather than the extreme variance actually experienced.

This sharp recovery from harsh drought conditions to lush pastures is great stuff for 'Discovery' channels, but the question remains, 'how does this relate to scary SD statistics on my fibre test reports'.

Fibre diameter variance – environmental influences:
Once an alpaca is conceived, its genetic influences on SD are set, they cannot be changed for the developing alpaca and these influences remain constant throughout its life. However, pre and post natal nutrition of the cria will have a profound impact on the development of the fibre follicles (from which fibre is produced under the skin of the animal), and therefore, will have an impact on the degree with which the genetic influences are allowed to be expressed in the eventual fibre. Environmental influences throughout an alpaca's life can substantially impact the SD, pushing the results up or down depending on the duration of the stressors.

As many would be aware, an increase in nutrition reaching the fibre follicles results in an increase in the diameter of the fibre being produced at that time. Conversely, reduction in nutrition reaching the fibre follicles results in a reduction in the diameter of the fibre being produced at that time. The degree to which the level of nutrition is increased (or reduced) influences the degree to which the fibre diameter is increased (or reduced) or, preferably, remains stable throughout the year.

Translated into practical terms, an increase in the quality and/or quantity of feed will normally result in fibre diameter Microns increasing. Conversely, a reduction in quality and/or quantity of feed for any reason will result in lower Microns. An increase in any stress to the animal will also cause microns to temporarily go down as the nutrition is diverted away from fibre growth to sustain the body's response mechanisms to deal with the stress. Examples of environmental stressors impacting on nutrition availability to the fibre follicles can include sudden increased worm burden, substantive injury or prolonged illness, changed social conditions (moving alpacas away from their usual group or being picked on by another dominant alpaca) as well as the obvious stress of change in available feed and nutrition levels due to seasonal variation for pasture fed stock.

The obvious case in point is the extreme variation in available pasture feed over the 2013/2014 fibre growing season. The first half from October to April saw a massive reduction in available feed, followed by a massive increase in available feed over the second half of the season, April to September. And many alpaca breeders will see this reflected in the SD component of their fleece test results for samples taken during the second half of 2014.

Variation in fibre diameter along the length of the fibre over a season is demonstrated in this extreme example of an alpaca fibre test from eastern Victoria, Australia after shearing in 2014. If you could see this sample under a microscope, its outline would look a bit like this:

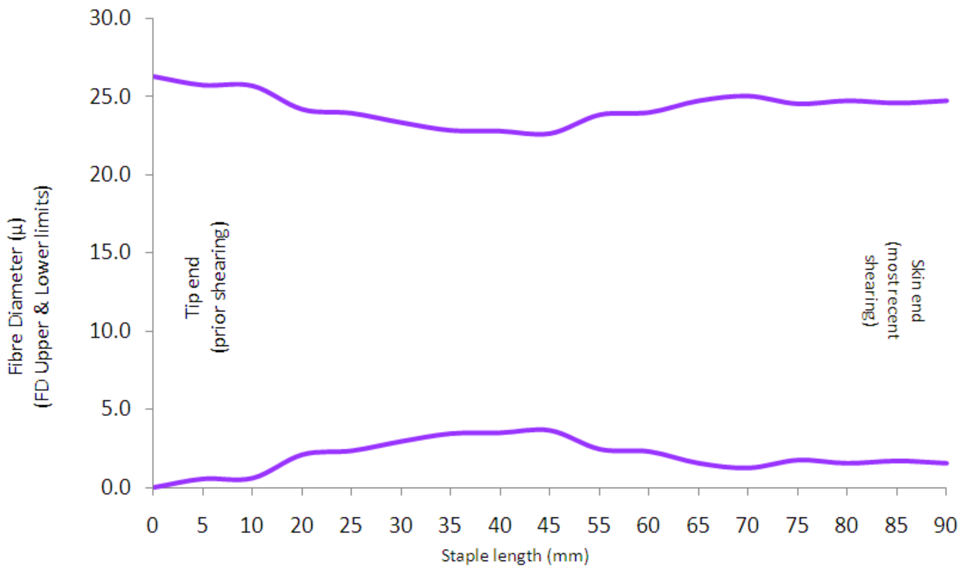

Figure 3 Fibre diameter profile average showing extreme variation along the fibre length
The narrowed point towards the centre of the fibre will be vulnerable to tender breakage when processing.

The micron profile of the alpaca shows that the fibre diameter at the time of prior shearing (left point of linear graph) was 26.3µ, fell sharply to 19.0µ before rising just as sharply to about 24.0µ. The diameter of the fibre then levelled off. The fibre was about 23.3µ at the point where the sample was shorn from the alpaca (right point of linear graph). The maximum variance in fibre diameter along the fibre length was 26.3µ – 19.0µ = 7.3µ.

Subjecting this sample to standard fibre testing using OFDA2000 technology, a standard fibre diameter profile and statistic data together with a histogram that all should be familiar with is produced. This sample's fibre diameter profile and data for 2014 show some marked variation from averages that alerted the owner to review and question the results:

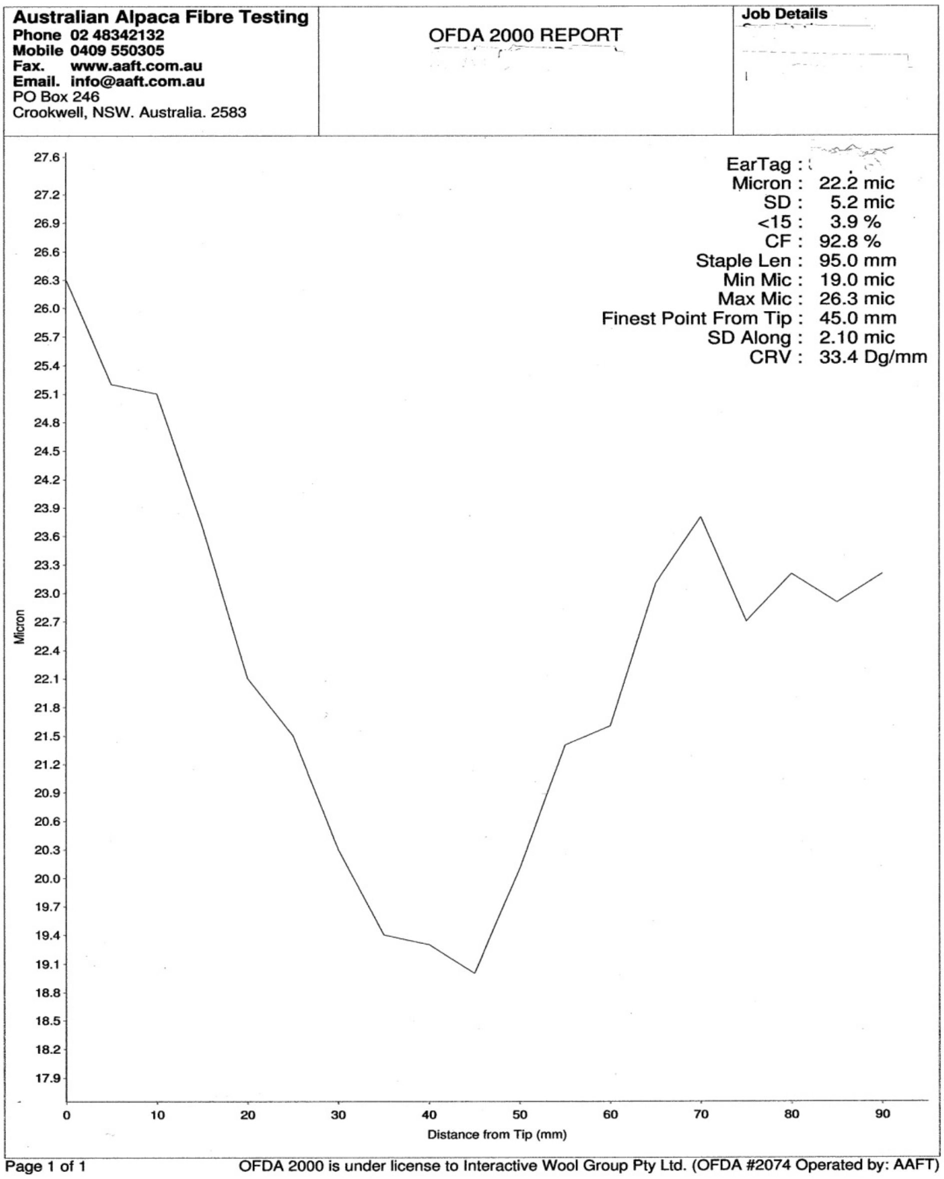

Figure 4 Fibre diameter profile as measured by OFDA2000

The variation in diameter along the fibre of this example shows marked environmental influence during this fleece's growth period. As this sample was taken after the extreme rainfall variance conditions experienced in 2013/14, it is likely that it was a pasture fed alpaca and the initial sharp decline in the micron was caused by the harsh, dry and hot spring/summer period. Conversely, the sharp increase in the second half of the season is likely to have been caused by the increase in nutrition brought on by the lush autumn. The last 25mm of the graph where the SD levelled out would probably be due to a levelling of available nutrition during winter.

How SD is calculated with OFDA2000 Technology:
The next step is considering how this affects SD when using OFDA2000 technology.

Overall (general) SD reported in fibre test results is calculated using an algorithm in the OFDA2000 testing machine as it scans down the length of the sample and measures the fibre diameter many times. It calculates the Overall SD using 2 main components:

- True (genetic) SD
- Variable (environmental) SD

Normally, the Variable (or environmental) SD is low enough that it has little impact on the True SD. This means that the Overall SD and True SD are generally about the same. But if the Variable SD markedly increases in value due to eg. extreme seasonal nutrition fluctuations, this will impact on the reported Overall SD.

How are these 2 components calculated? When using OFDA2000 technology, the fibre sample diameter is measured along its whole length. As the fibre sample is measured, the variation in fibre diameter comes from two sources.

1. Variation in fibre diameter along the fibres (environmental nutrition based variation)
2. Variation in fibre diameter between the fibres in the bundle (genetic based variation)

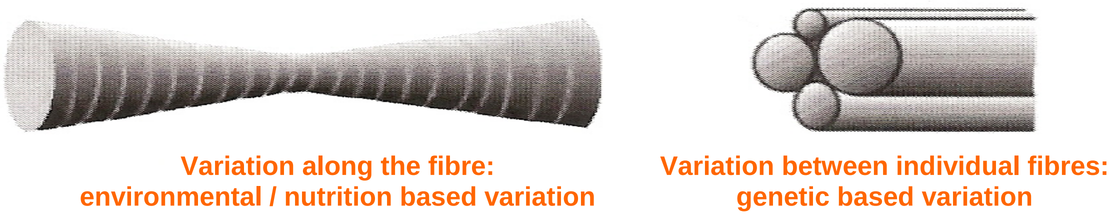

Figure 5 Diagrammatic representation of variation along fibres and variation between fibres (True SD)

Remembering that when measuring the width (diameter) of fibre samples, the SD figure represents the overall variation (in diameter) of the fibre within the sample. Standard deviation is a statistical calculation that represents how far either side of the mean (average) you need to go in order to capture about two thirds of the total variation in diameter for the respective sample.

With the first source, the variation in diameter is the difference in the average diameter for each individual fibre within the sample. For alpacas, the difference in diameter between individual fibres within a sample is normally between 25 to 35µ. For example, for an alpaca fibre sample with an OFDA2000 reported average Micron = 20.0µ, you would expect to see the finest fibres being about 10 to 15µ, while the broadest fibres being about 35 to 45µ. This form of variation is depicted in the histogram graph provided with fibre test reports.

With the second source, the variation in the diameter along the fibre is caused by variation in the amount of nutrition reaching the fibre follicles. This is the form of variation in diameter referred to above, ie, the variation influenced by aspects such as seasonal fluctuations. For alpacas, the normal variation along the fibres is about 2µ to 5µ. As mentioned above, this variation is depicted in the micron profile linear graphs provided with fibre test reports.

SD as a reported value therefore represents the overall variation of both the variation along the fibres as well as the variation between the individual fibres.

Normally, the variation between the fibres is the dominant cause of variation within a fibre sample. It is also the form of variation that is largely caused by genetic influence. Therefore, the variation between fibres is the part of SD that we are trying to improve with our genetic breeding programs. Because it is normally the dominant component of SD, using the overall SD statistic found in fibre test reports is an effective tool with which to breed higher quality fleeces. However, the 2013/2014 season was not normal.

The micron profile above shows an extreme degree of variation along the length of the fibres, ie. 7.3µ compared with the normal 2-5µ range for SD and this is caused by higher than normal fluctuations in environmental influences. This environmental influence on variation was far greater than normal, and consequently, played a much greater influence on the SD figure than normally occurs.

The alpaca example above was a Huacaya and we would expect the SD to be, eg, 4.6µ or less. At 5.2µ, this alpaca appears to be an alpaca that would not be considered suitable for genetic improvement towards fibre quality. However, as shown, the SD figure in this case was abnormally influenced by seasonal factors and thus the OFDA2000 algorithm has calculated an excessively high Overall SD.

So how do we extract the extreme environmental influence and get to a True SD value so that we can make appropriate judgement on the alpacas true value for breeding stock?

When reviewing the micron profile along the fibres of the above example, the last 25mm of the sample indicates little environmental influence on the sample’s diameter variation. By sectionally sub-sampling and testing the last 25mm of the sample, we are able to remove the impact of the extreme environmental variation, thereby confining the SD measurement to that of the genetically influenced variation between the individual fibres – the True SD.

The micron profile below was generated from the same sample but restricted to the sectional sub-sample which tested only the last 25mm of the fibre sample. It can be seen that the Overall SD has been reduced from 5.2µ to 3.9µ by removing the extreme degree of variation along the fibres. The SD of 3.9µ represents a more true indication of the breeding potential of the alpaca for genetic improvement of fleece quality.

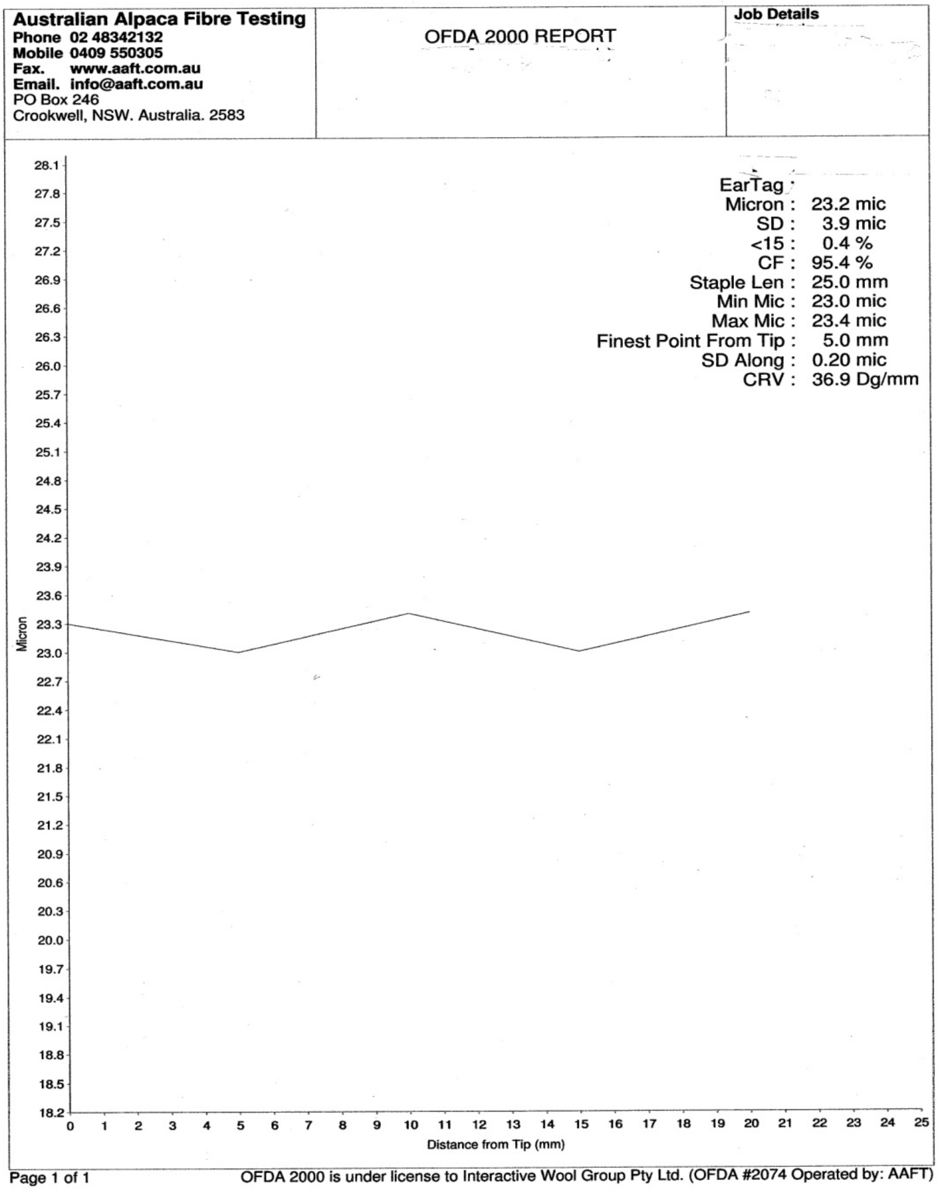

Figure 6: Sectional sub-sample fibre diameter profile demonstrating removal of environmental influences

It should be noted that the reported SD Along on the first profile is 2.1µ (see Figure 5). This is the SD calculation for just the variation along the fibre. It is very high as it is reflecting the extreme variation in fibre diameter measured along the fibre length. The SD Along for the 25mm sectional sub-sampled portion is only 0.2µ which indicates there is very little variation along the section tested.

It is also worth noting that the flat portion of the micron profile can be found at any point along the sample. To effectively carry out this sectional test to determine 'genetic' or True SD, an examination of the entire profile is required.

The Good News…

Good stock husbandry of your alpaca herd has to be maintained at all times throughout the year to minimise the impact of environmental influences on fibre diameter variation. However, we cannot totally eliminate these influences and sometimes illness, stress and/or climatic conditions will conspire against us. When we can't totally obliterate all environmental influences on SD, we can at least look closely at the fibre test results and determine when and how (if possible) to obtain SD results that will closely approximate True SD results. This will only be required when variance in diameter along the fibre is substantively impacting the overall SD, ie. when it is greater than 5µ and/or SD Along is greater than or equal to approximately 1.2µ.

If you have fibre test results where the profile visibly shows marked variation along the fibre length (ie. ≥ 5µ) and where the results for SD Along is ≥ 1.2µ, you should discuss this with your fibre testing provider. Specialist sub-sampling for sectional testing may be able to be conducted to reduce the variable environmental influence on the Overall SD and gain a True SD result.

And finally, if you have prize genetic stock, always review the fibre testing results closely and if anything seems out of the way, discuss the results with your fibre testing provider first. With a Micron of 23.3µ and "True" SD of 3.9µ as demonstrated by the sectional sub-sampling test results, the Huacaya in this example was well worth considering for stud sire material instead of being written off and castrated.

Paul Vallely, Co-author of this paper, discloses a commercial interest in the findings of this paper as owner of Australian Alpaca Fibre Testing (AAFT).
Jennifer Errey is a Scientist who together with her husband, Robert, operates Errydge Park Suri stud in Nth East Victoria. The extreme environmental impact of the 2013/2014 weather patterns on the fibre diameter profiles and SDs of their Autumn 2014 cria drop is the subject of a separate paper.