This booklet is an introduction to a better understanding of what is alpaca fiber, how it grows and how breeders assess it
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The acquisition of information takes many years and exposure to many ideas over time. I would like to extend my personal thanks to Dr. Jim Watts, Dr. Ian Davison, Cameron Holt and Ken Madl for their mentoring and/or assistance in my learning of matters alpaca fiber.

I would like to acknowledge the photographs generously provided by Dr. Jim Watts and his SRS® company - they make understanding so much easier!

Ian Watt

Preface

In a world that trades more competitively – and more ruthlessly – than ever before, growers of alpaca fiber face a future that will demand excellence as the norm and an exceptional product, as the measure of success.

The alpaca industry outside of South America is dominated by interests not necessarily aligned to the commercial production of one of the world's most exciting and natural fibers. In the show-ring, fiber comprises 60% of the animal evaluation in the United States of America and Australia – the two largest alpaca populations outside South America.

Most breeders extol the virtues of the fiber with relatively few promoting objectivity of fleece appraisal in their extensive marketing and advertising.

This is despite a wealth of knowledge and technology that could be used to bring greater understanding and credibility to an industry that is still very vulnerable to advances in wool and man-made fibers.

Alpaca breeders come from a wide range of occupations and age groups. They come together as a group interested in one thing and one thing alone – the alpaca.

The pioneers of the industry outside of South America entered an industry from a very, very low knowledge base and invested heavily in the exoticness of this hugely attractive member of the camelid family.

Newcomers enter the industry with much more extensive information available to them and the expertise of breeders who have gathered their skills through trial and tribulation peppered with large doses of painful personal experience.

It seems that everyone 'knows' about alpaca fiber.

It is apparent that what one person 'knows' and another person 'knows' can, and often are, poles apart in some, if not all, of the traits that make up a fleece.

Writing this booklet is a challenge and will undoubtedly bring a wave of disagreement from some, but there is a need for somebody to put down a work that will bring it all together in the one volume, as a base from which we can all move forward.

If readers become a little better informed, learn something new and are more successful as a result of reading this article, then I am content!

Ian Watt

ALPACA FIBER - AN INTRODUCTION PAGE 1

Chapter 1

What is alpaca fiber?

The alpaca industry has struggled to find a common descriptor for the coat of the alpaca. As a member of the camelid family of animals, it could be argued that the coat is really hair but others prefer to call it wool whilst most generally recognize it as fiber. Whatever the name, it will be identified as fiber in this text.

Alpaca fiber is a harvestable coat formed in the skin and grown on the alpaca animal. It is a fiber that comes in many different qualities, a wide range of colors and in two distinct types – huacaya and suri.

It is composed of three distinct fibers comprising primary, secondary and derived secondary, grown from primary and secondary hair follicles located in the skin.

As a further complication, some fibers are medullated, many partially medullated whilst some are solid.

Medullated fibers are hollow to varying degrees and are sometimes straight, the most obvious being the primary fibers, which create the 'halo' often seen on younger animals in particular. After examining nearly a thousand alpaca biopsies it can now be asserted that a high proportion of secondary fibers are either medullated or partially so at one point in time. This is an interesting discovery as medullation, to date, has only been measurable in white and light fleece samples tested through the OFDA 100 machine – biopsies allow all colors to be examined for medullation.

> Authors note: I have made a conscious decision to use Australian wool industry terminology where it fits with similar or identical alpaca fiber characteristics in preference to establishing a new set of descriptors that can only confuse international traders in alpaca fiber – our customers of the future. As much of our information on alpaca fiber correlates closely to that of wool producing sheep (mainly the merino), it is useful for readers, breeders and growers to understand any perusal of wool industry research and information they may care to make.

Alpaca fiber comes in a wide range of colors ranging from white, through fawn, brown and grey to black.

These colors are further divided into light, medium and dark for the fawn, brown and grey colors in Australia, and even more in the Unites States of America where black is separated into two tones and grey into a further category of rose grey and still another color of beige sitting between white and fawn. More recently, a new 'color', indefinite light and dark, has been introduced into the show circuit in the United States.

In South America the color of preference is white, which probably explains why the bulk of superior fleeces throughout the world are white in color. South American processors recognized that the world demand was for white fiber with the result that white was the focus of breeding plans in Peru, Chile and Bolivia.

This demand is fuelled by the ability of white fiber to take all colors of commercial dye and thus maximize the marketability of the finished product.

As all alpacas in the world originated from one or other of these three countries, it is perhaps not surprising that white fleeces are the benchmark by which others are measured in terms of fineness, uniformity of micron and color, and consistency as a whole.

Chapter 2

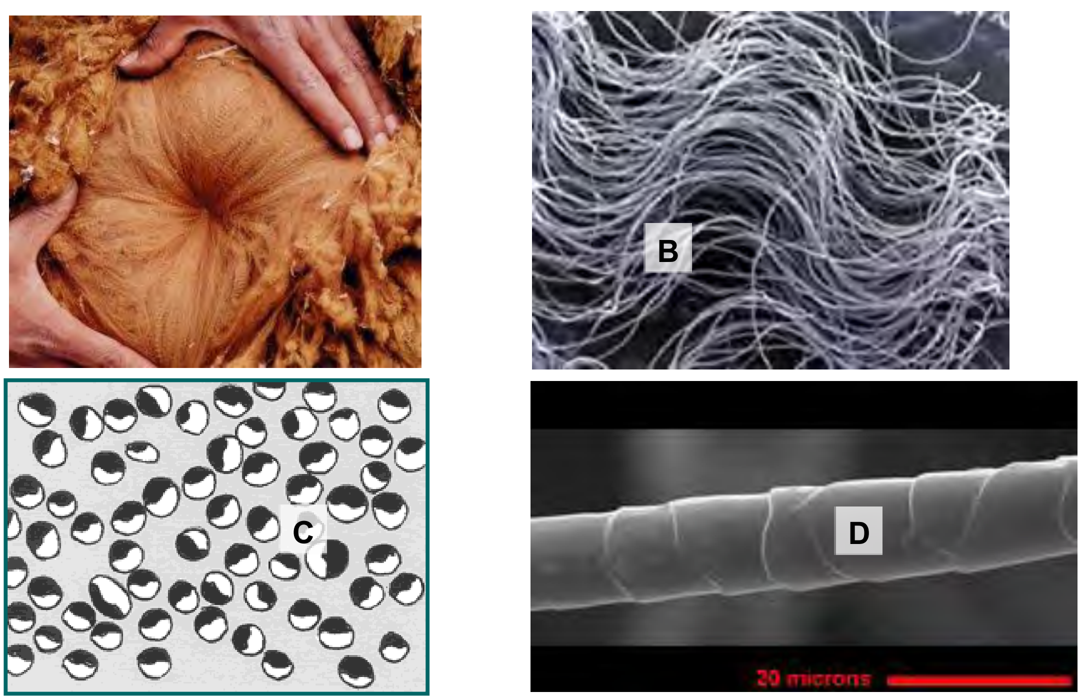
COMPOSITION OF THE FIBER

Alpaca fiber is composed of three primary parts:

1. Para and ortho cortical cells
2. Cuticle or scale, and
3. Intercellular binder

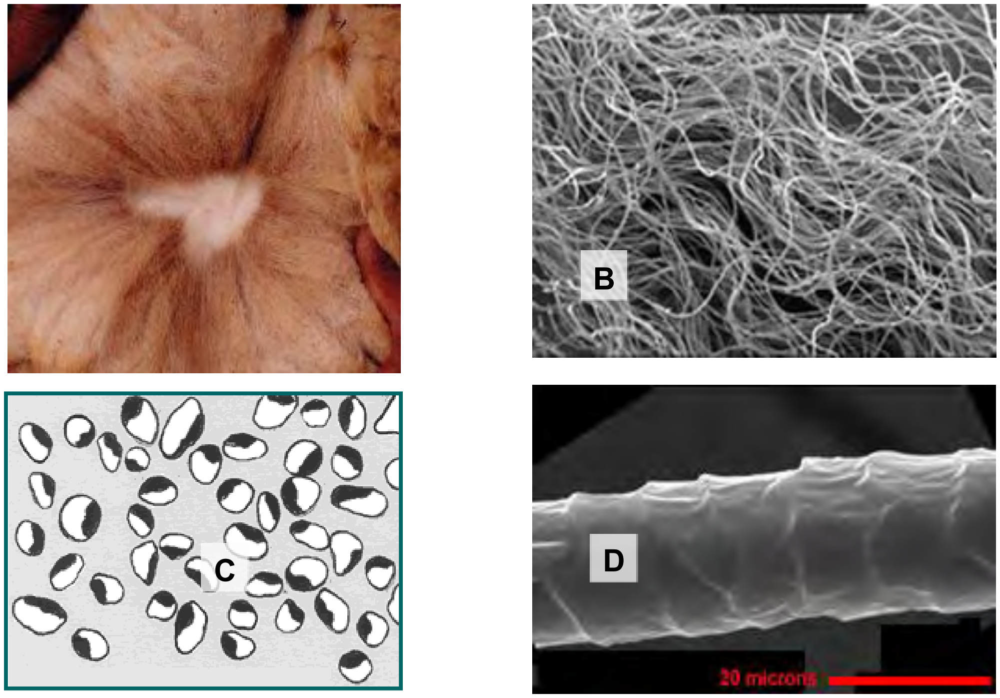
Cortical cells – are the cells that make up the strength of the fiber and, in effect, create the crinkle and crimp. It has been observed that the orthocortex (orthocortical cells) is always on the outside of the crimp curve which means that it, and the paracortex, twist to create the curve of the crimp, much like a two ply yarn that is twisted upon itself to create kinks, with the structural difference being that the fiber is more controlled in how it performs. As the two cortical cell types grow alongside each other it follows that the orthocortex provides the tension that allows the curve of the crimp whilst the paracortex is of lesser tension thus allowing the crimp to stay in place.

Cuticle or scale – each fiber is sheathed in a covering material known as the cuticle but more commonly defined as the scale. The scales protect the cortical cells, provide some structural strength, provide the softness (or otherwise) of what is called the 'handle' and reflects luster. The scales differ in length and height, which affects reflective ability more commonly referred to as luster in suri and brightness in huacaya.



Long fibre bundles (A) are formed by fast growing fibres that are densely packed and highly aligned (B), fine, evenly sized and cylindrical in shape (C), and have smooth surfaces formed by long, flat scales (D).

B gives high crimp amplitude and low crimp frequency. C and D give softness. B, C and D give lustre.



Thick and short staples (A) are formed by slow growing fibres that are sparsely packed and entangled (B), coarse and uneven in size and shape (C), and have rough surfaces formed by short, protruding scales (D).

B gives flat and fine crimp C and D give harshness B, C and D give a non-lustrous finish

The dark section represents the paracortex and the white the orthocortex – the equal the proportions, the more round the fibers.

When the para- and ortho- cortex are out of balance the fibers do not crimp evenly or in unison, the scale height is higher and the staple is both fatter and cross-fibered.

Intercellular binder – is the 'cement' that holds the cortical cells together within the scales.

It is interesting to observe that as fiber diameter increases, the frequency of crimp decreases which is caused by a movement in the percentages of ortho and para cortical cells in the fiber. This breakdown shifts the balance between the types of cells and so reduces the tension differences between the two causing the crimp to broaden until the cells are almost indistinguishable in a straight fiber in huacaya fleece. There is reported to be no visible line of distinction between the two cortical cells types in the suri fleece – a fleece that has waves as distinct from crimp.

FIBER TYPES WITHIN A FLEECE

Primary fibers

These are the fibers around which follicle groups are formed within the skin. They are the relic of guard hair found in primitive types of alpacas and are easiest seen on the brisket, bib or apron, of an alpaca as long, straight hairs that project beyond the length of the finer, and softer, down underneath – hence the descriptor 'guard hair' – to guard the softer and downier undercoat.

Primary fibers sometimes appear in young alpaca (named 'cria') as a halo effect, which, in lighter colored animals, becomes less noticeable as the animal ages. This expression is usually related to a lower level of density as the crimping secondary fibers force the early primaries to conform within the staple. In the developing fetus the primary hairs start to grow before the secondary fibers and so are under no pressure to conform to the higher number of crimping secondary fibers surrounding the primary in each follicle group.

Primary fibers in less dense alpacas are usually higher in micron than those in denser animals.

Interestingly, as density increases so the primary fiber diameter decreases, as the pressure of secondary follicles forces the primary to conform to the group average as they form tight, individual bundles of closely aligned fibers.

In fleeces that are not dense (as determined by follicle numbers per unit area of the skin) the primary follicles may be as strong as 30 microns in young animal fleeces. As animals age, the fiber naturally strengthens in micron heading toward the upper limit of the primary follicle micron count.

Secondary fibers

Secondary fibers make up the undercoat or down of the fleece and are the finer, softer fiber that gives alpaca its luxury feel and improved insulation attributes. These fibers gather around the primary fibers to create follicle groups with the more secondary follicles to primaries creating finer, softer and more uniform fleeces. These fibers create the crimp, which is exhibited as waves within the staple or lock. Crimp style varies within the huacaya fleece type (there is no crimp in suri) ranging from high frequency, low amplitude (slower growing fleeces) to lower frequency and higher amplitude in faster growing fleeces.

Individual fibers exhibit a characteristic called crinkle (exposed when the staple is broken up into individual fibers as happens in the processing chain) which are irregularly spaced variations in the direction which the fibers take as they grow from the skin.

This can best be illustrated by observing the formalized crimp structure in the lock and then removing individual fibers to see the change – the crimp disappears and what is seen is a fiber not straight, but with changes of direction along the length.

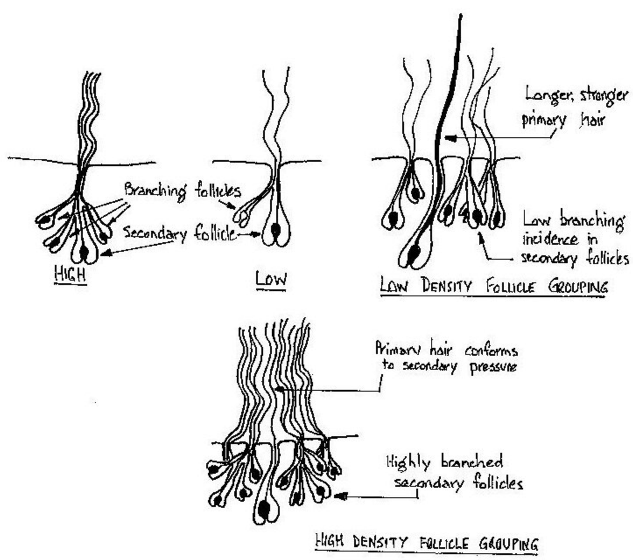
Derived secondary fibers

These fibers are usually the finest fibers within a fleece and get their name because they use the secondary follicle exit from the skin. They have their own follicle root and enter the follicle sheath from the side and then share the same exit point from the skin.

These fibers are the finest the alpaca produces and form a higher percentage of fibers in the fleece of elite alpacas.

Derived secondary fibers cannot be identified within a fleece sample but are identifiable within a properly prepared skin biopsy.

They are highly desirable fibers.



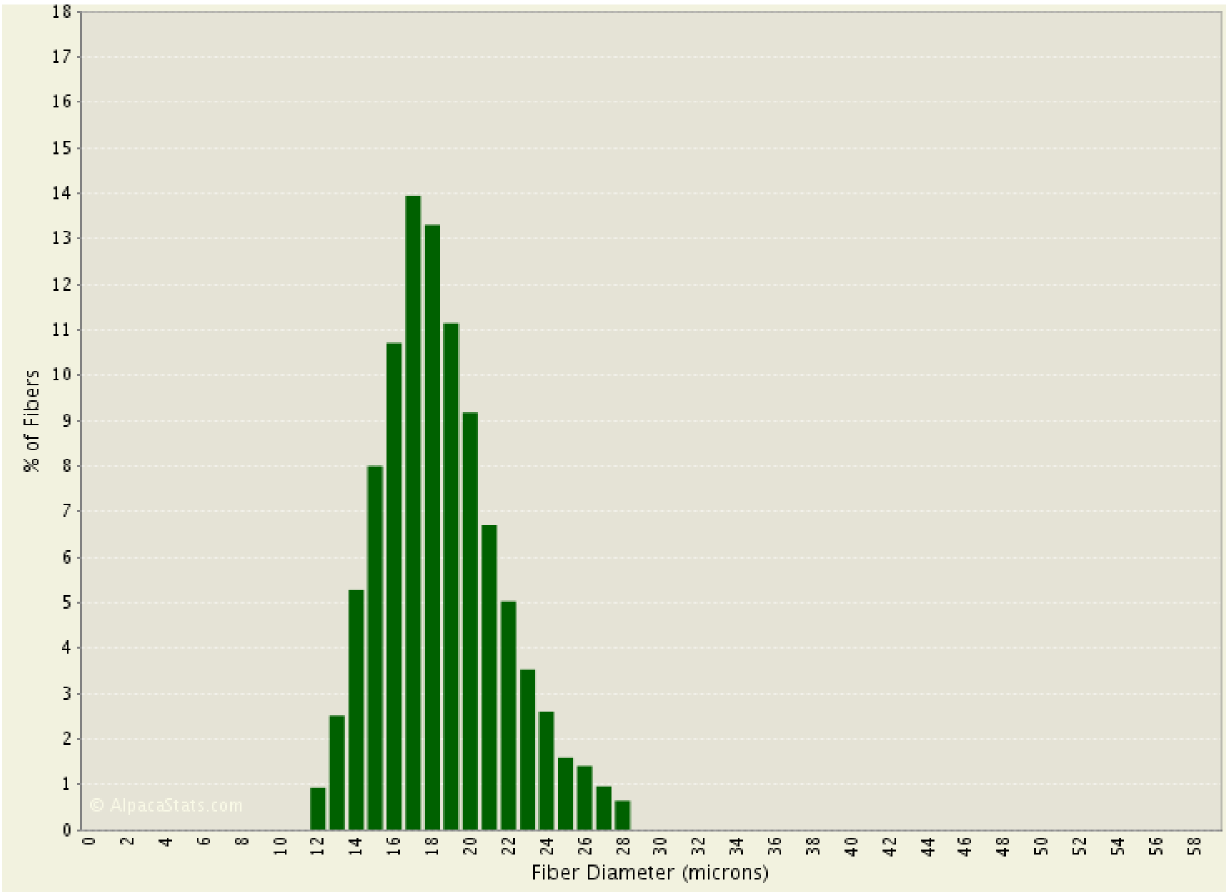
Medullated fiber

Many people, including alpaca breeders, limit medullated fiber with primary follicle fibers and/or guard hair.

There is a difference between the two descriptors but more importantly is the fact that medullated fibers are produced within the fleece by fibers that are not only sourced from primary follicles.

These are the more insidious fibers as they do not necessarily have that ‘halo’ look as a visual identifier to the human eye.

They do appear in histograms as strong micron (many Americans use the word coarse to describe what the world wool industry calls strong) and can be more clearly defined by using an advanced fleece measuring and recording methodology.



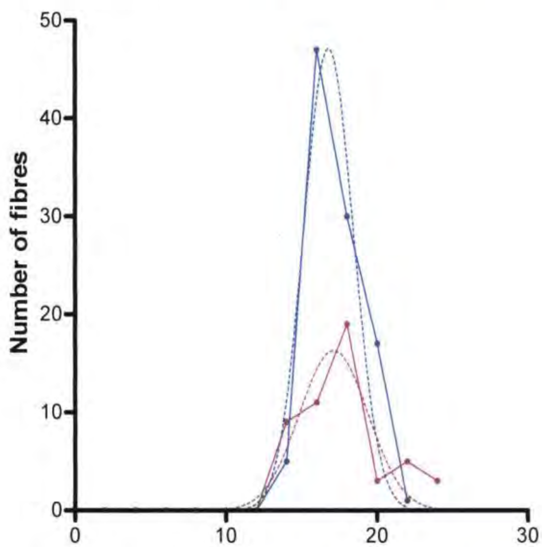
A standard micron histogram.

In this histogram it is likely that some of the primary fibers are in the 20 – 24 micron range but it is impossible to tell from a simple OFDA test which is which.

Mean fibre diameter (microns)	17.0	Crimps per cm	
Secondary follicle to primary follicle ratio	28.2	Fibre growth rate (mm per day)	
Follicle density (per mm^2)	103.5	Fibre length to staple length ratio	
SKIN THICKNESS (mm compressed):	0.96	**CYLINDRICAL FIBRES (%):**	

DIAMETER DISTRIBUTION OF PRIMARY AND SECONDARY FIBRES

	PRIMARY FIBRES	SECONDARY FIBRES
Mean (μm)	17.5	17.0
SD (μm)	2.6	1.8
CV (%)	15.1	10.3
Min (μm)	14.0	13.0
Max (μm)	23.0	21.0
Medullation (%)	0.0	0.0



A biopsy histogram showing the primary fibers sitting within the secondary numbers which has to happen to get low Standard Deviation numbers like merino wool.

These histograms present two traditional bell curves, one within the other, that clearly show the population of primary fibers within the sample tested.

Medullated fibers cover a range of types including solid, hollow and various grades between the two extremes. They create problems for the processors in that they do not accept dyes uniformly or as readily thus producing variations within the yarn that make it largely unacceptable for premium markets.

They present customer acceptance problems for processors because they have sharp ends, which protrude from the finished product and create a prickle factor when felt against the skin. Because 'prickle' has a negative connotation, the industry ihas adoptedthe more acceptable 'comfort' factor descriptor. Comfort factor is defined as the percentage of fibers over 30 micron based on research in the Australian merino wool industry that showed human discomfort when fibers of 30 micron (and over) were found in wool products worn next to the skin.

They also do not necessarily have the crinkle or elasticity that meld them into the non-medullated fiber and so cause a prickle factor in the finished yarn.

In the early days of industry development in both Australia and the United States, much was made of the superior insulation benefits of this miracle fiber with its hollow nature being the reason that alpaca fiber was five, eight, ten times better than the best wool.

This claim is without foundation and has been debunked for some years now but it is occasionally aired with conviction.

Estimates about the percentage of hollow fibers within an average fleece vary enormously with current thinking placing it somewhere in the vicinity of 5 to 10%. In this context, the supposed insulation benefits created by hollow fibers is far, far less than that gained from the trapped air between the fibers in the finished product.

Of importance to breeders is the micron of medullated fibers with industry, both breeder and processor, concentrating on fineness of micron as a primary breeding goal. Medullated fibers usually occupy the right hand side of the histogram, the stronger micron range within both the fleece and the sample.

Chapter 3

HOW FIBER GROWS

Follicle formation in the skin

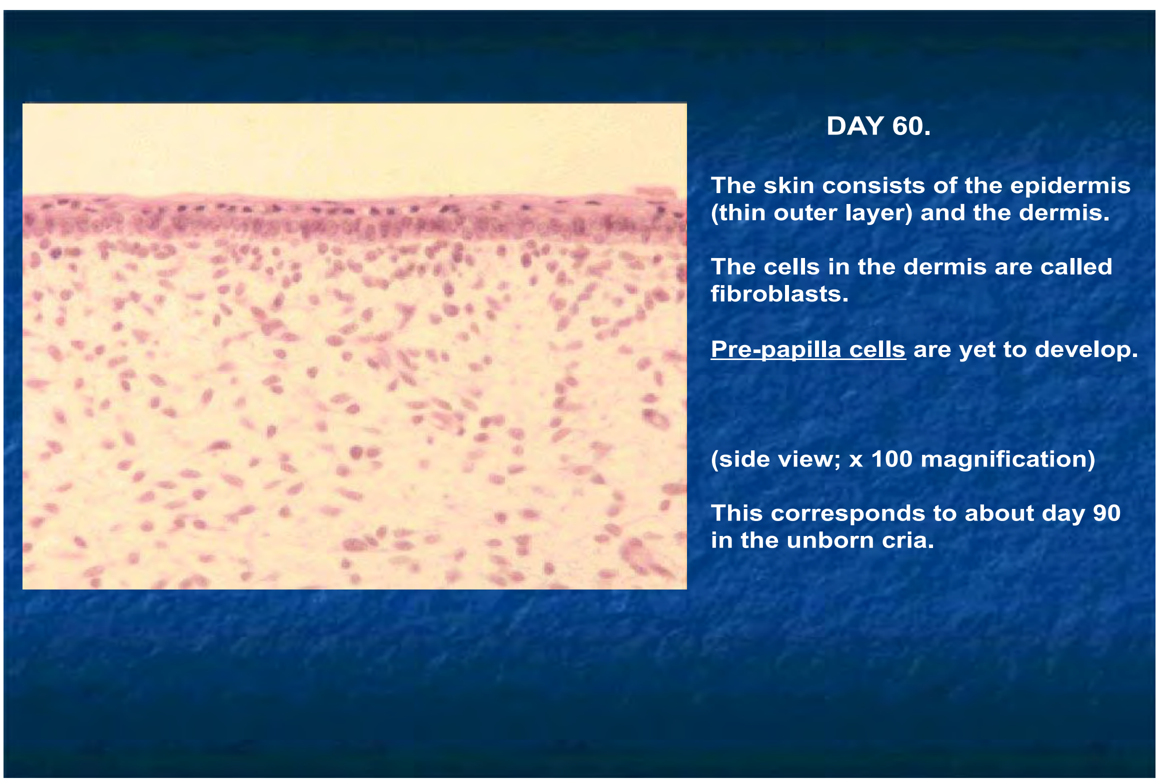
Many fiber coated animals share a common expression of fibers in the skin. Alpacas are no different and form their fiber follicles in groups developed around a primary follicles. It follows then that to get more follicle groups, there must be more primary follicles. Therefore, to select, and breed, against primary fibers will lower density and fleece yield.

Primary follicles are set in the skin in the first three months of life after which follow the secondary and derived secondary follicles. Fiber is expressed from the skin during the last trimester of pregnancy.

Chemical messages cause a proportion of these fibroblasts to convert into pre-papillae cells, which are independently dispersed throughout the future epidermis layer. These cells are to become the hair follicle root.

Further chemical messages and changes cause these cells to randomly group throughout the epidermis. As they group, the epidermis forces them into the dermis where they are engulfed by the downward pressing sheath to form the hair follicle root.
The skin comprises the epidermis (the outer layer) and the dermis, the under layer.

In evolving the skin, the fetus develops a layer of fibroblast cells in the epidermis. These fibroblasts are the precursors to collagen cells, which eventually thicken to create the epidermis.



Some of the fibroblasts in the dermis change into <u>pre-papilla cells.</u>

Pre- papilla cells form clusters.

Pre- papilla cells are committed to forming wool follicles and fibres.

The more pre-papilla cells that are formed, the greater the potential the animal has to lay down a high number of wool follicles.

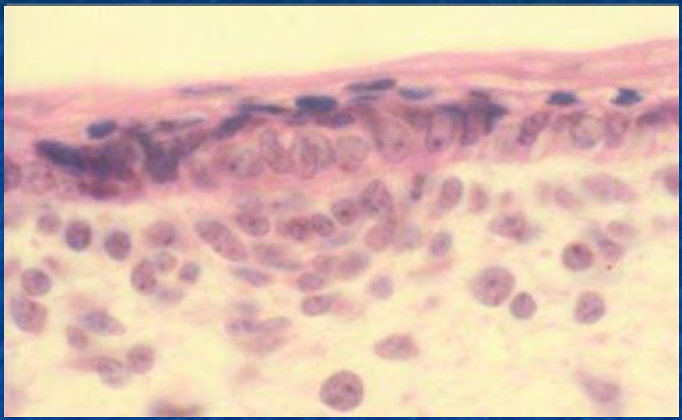
(x 260 magnification)

DAY 80.

The rapidly multiplying epidermal cells push the pre-papilla cell cluster down into the dermis.

DAY 90.

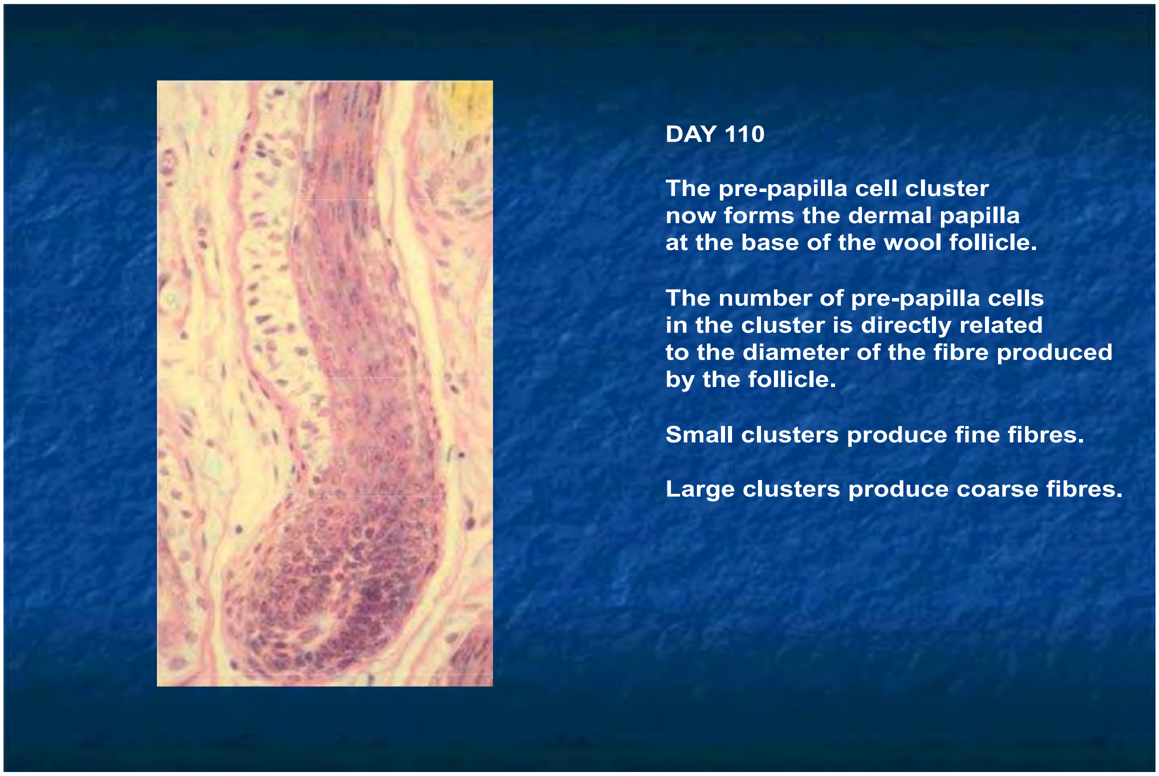
The epidermal cells engulf the pre-papilla cell clusters.



DAY 65.

A cluster of pre-papilla cells, now in intimate contact with the epidermis, stimulates epidermal cells to multiply.

(x 300 magnification)

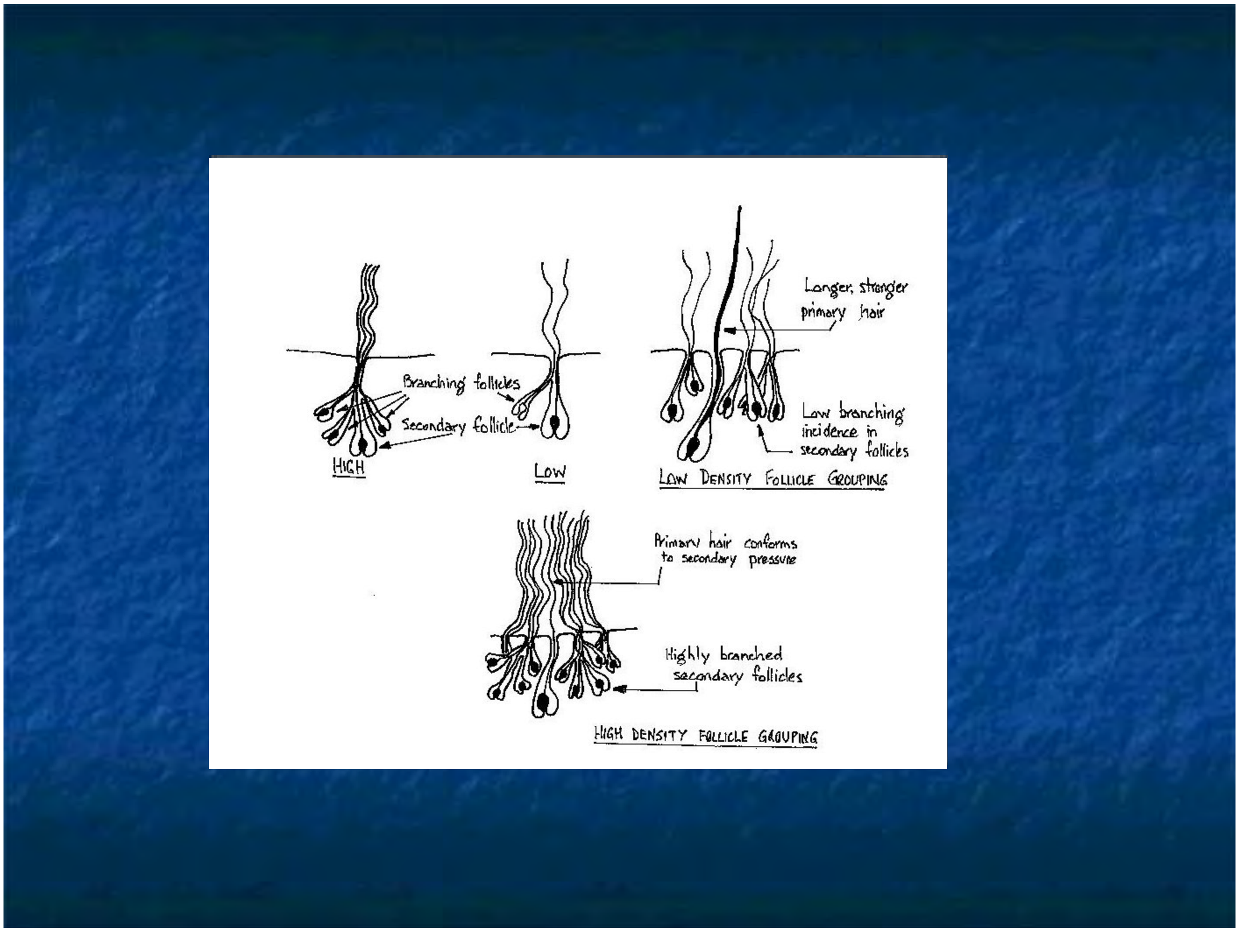


During the laying down of the secondary follicles, a number of ‘branching’ follicles are created off the secondary sheaths. These follicles are formed in the same way as the secondaries, with the important change being they share the same skin opening. Because of this feature, the hair from these follicles is significantly finer than the ‘host’ follicle, and so form the finest fiber in the follicle group.

It is probable that these ‘branching’, called derived, secondary follicles are finer for two main reasons:

1. There are fewer prepapillae cells from which to draw for the formation of the follicle bulb, and

2. The pressure of a number of hairs exiting the same skin opening causes the hair to not only squeeze through by becoming finer but also longer because of that squeezing action.



Branching follicles
Secondary follicle
HIGH
LOW
Longer, stronger primary hair
Low branching incidence in secondary follicles
LOW DENSITY FOLLICLE GROUPING
Primary hair conforms to secondary pressure
Highly branched secondary follicles
HIGH DENSITY FOLLICLE GROUPING

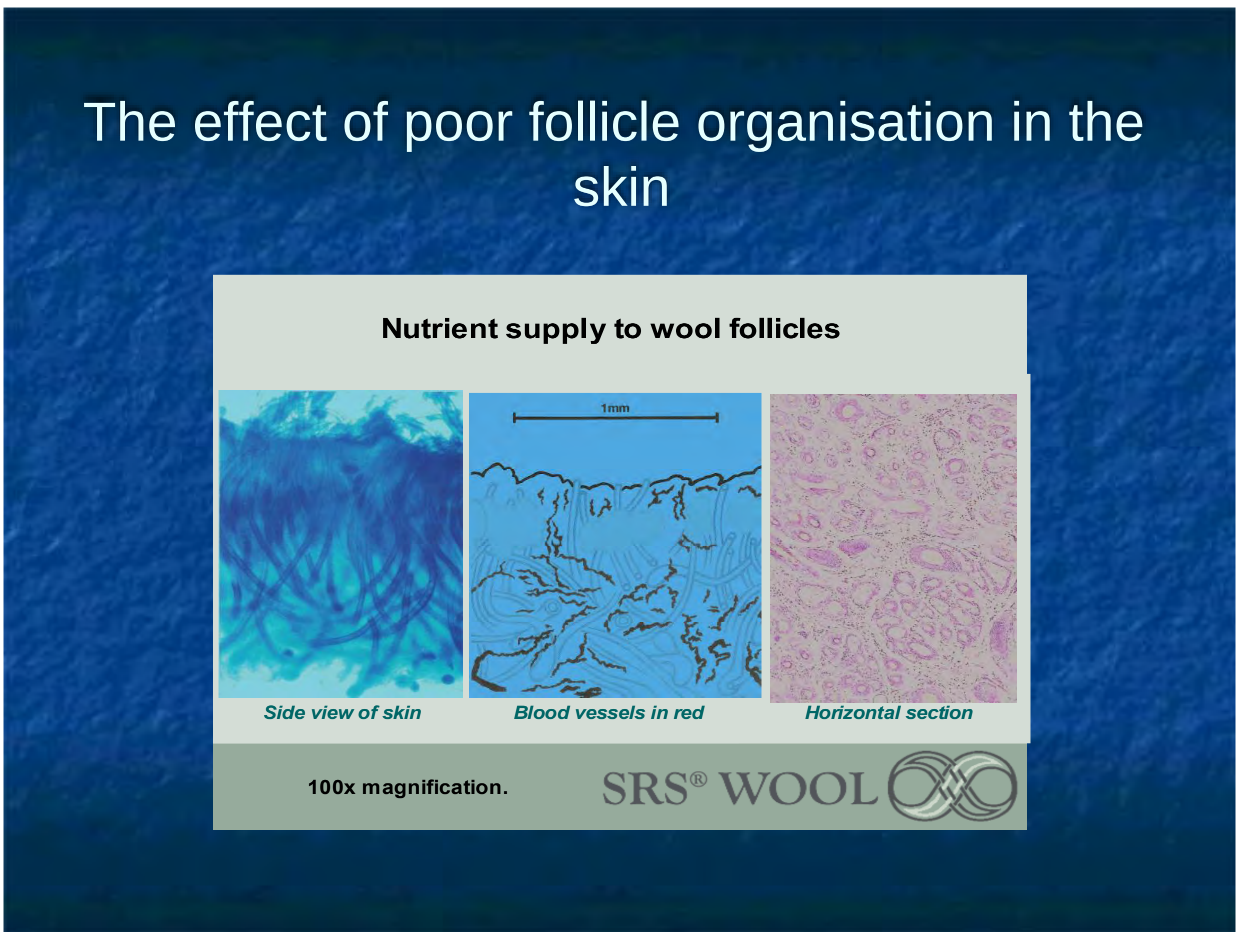
The timetable for each of the three distinct stages of follicle development is thought to be:

1. Primary follicles – 90 to 147 days
2. Secondary follicles – 187 days onwards
3. Derived secondary follicles – 264 days onward.

It is important to note that the formation of the secondary follicles has commenced some time before the derived secondaries commence formation. While the derived secondaries are in place by birthing, the expression of the hair may take some time after birth to become evident.

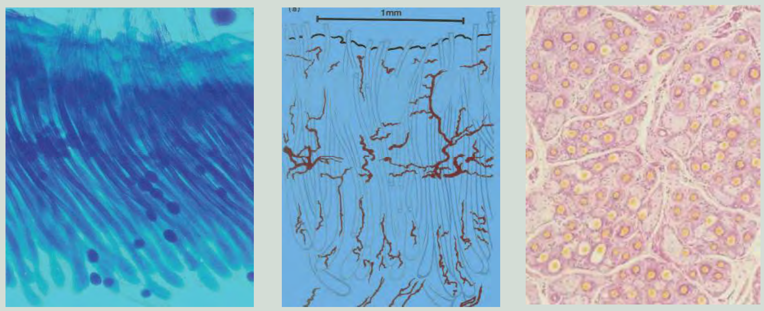
Primary and secondary hair expression commences in utero during the last trimester of pregnancy, perhaps with some of the earlier laid down derived secondaries being expressed at the same time.

This would perhaps partly explain the often talked about increase in fiber density some breeders notice after the first shearing.



The effect of high follicle organisation in the skin

Nutrient supply to wool follicles



Side view of skin — *Blood vessels in red* — *Horizontal section*

100x magnification.

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Chapter 4

ASSESSING FIBER – BY TECHNOLOGY AND BY HAND

The assessing of alpaca fiber can appear to be a daunting thing for many people entering the industry but it is amazing how many people believe themselves to be expert within weeks of getting their hands into fleece.

> When assessing fleece it is important to recognize that the various components go in to make up the whole. Concentration on one or two aspects only can easily deny other important traits to the detriment of a breeding plan.

For example, there is an emphasis placed on micron (the thickness of the fiber) often at the expense of uniformity of length, color and definition, all of which are important considerations when assessing quality.

> Successful breeders will utilize objective measurement data as part of their arsenal of selection tools, which will also include the use of both their senses of touch and visualization.

Alpaca fiber is all about sensation; the sensation of touch as reflected in smoothness, softness, evenness and, in the case of suri, slipperiness, and visually by brightness (luster in suri), crimp and color.

Objective measurement should never be the sole arbitrator in the decision making process but it should be an essential part of the breeders decision making toolkit.

UNDERSTANDING OBJECTIVE MEASUREMENT OF FIBER

Objective measurement descriptors

It cannot be stressed too much that objective fleece measurements are a breeding selection tool and must be viewed as a helpful selection and measurement aid rather than definitive.

Placing emphasis on one or two measurements over others will limit the scope and viability of the breeding decision.

Objective measurement is a necessary selection tool for the serious breeder as it not only allows independent comparison between animals, but also provides a benchmark for evaluating future progress.

The Histogram

The histogram is a graphic representation of the distribution of the technological measurements within a fiber sample.

The histogram represents the distribution of the number of sample fibers according to their individual micron count and their numbers for each micron count. Plotted on a standard graph base with numbers of fibers along the side axis and the micron count along the base axis, the reader can immediately gain a distinct interpretation of the fleece sample from the graphic depiction.

The left hand side of the distribution curve is always the finer micron with the histogram of finer fleeces always depicted toward the left hand side of the graph.

The histogram itself is in the form of a graph reflecting a typical bell curve of distribution with thin, tall representations indicating superior fleece samples, and wider, flatter curves representing stronger (and, by inference) poorer fleece characteristics.

Most histograms are presented across the bottom axis of the graph with some represented on the side axis.

Some histograms vary in scale dimension, which makes comparison between fleeces sometimes difficult.

It is important, when comparing histograms that attention is paid to the scale as the shape of the curve of distribution can alter dramatically depending on the scale being used.

Staple Length

Staple length is probably the single most important consideration given by buyers when assessing fleece for purchase and processing. Staple length is affected by crimp definition, by nutrition and environmental influences, and genetically.

Staple length is always measured in the stretched state.

Broad, bold crimp is generally associated with longer staple length with the ultimate expression being suri, which has no crimp.

High frequency, tighter crimps are associated with shorter staple length and tend to sit those fleeces at the lower end of processing acceptability when their shortness is an issue. Generally speaking, a five inch (120mm) length staple is the maximum length for superior fiber processability for top-end retail product. Generally speaking classing fiber lines by length identifies 90 - 120mm (3.5 to 4.5 inches) as premium length followed by 70 - 90mm (2.75 to 3.5 inches) .

Staple length can be affected by environmental factors including weather and is most affected by age and reproductive activity with older animals progressively getting shorter staples and pregnant and lactating dams also producing shorter fleeces.

Micron

A micron is 1 millionth of a metre, or 1,000th of a centimeter – by any measure, a very fine measurement.

It has already been noted that fibers with a thickness exceeding 30 micron causes a prickle sensation when worn against the skin. It follows then that very fine fiber does not prickle and can be worn against the skin comfortably. Fineness also translates into softness and lightness when processed into a product.

In years gone by, fineness was estimated by linking crimps per unit of length to a count, which reflected fineness (called the Bradford Count). With the advent of lasers and HD camera's, measurement of fibers could be much more reliably done and the weakness of equating crimp with fineness was exposed. It is fair to say that highly crimped, shorter fleeces sit at the finer end on a scale of fineness, but it is not fair to imply that longer fleeces with bolder, less frequent crimping cannot also be as fine.

Crimp cannot be used to define fineness with any consistent accuracy.

Traditionally, low micron fleeces cut lower weights per animal, which makes the economic production of these types of fleeces truly dependent on premium pricing structures.

It is worth noting that mechanical measuring of micron does not have an accuracy any better than 0.6 micron. In other words, a fleece of 20 micron cannot be said to be finer than one of 20.6 micron measured by the same technology.

Standard deviation

Standard deviation is a calculation designed to indicate how consistent the micron spread is through the sample being tested, and, by implication, the consistency of the micron through those parts of the fleece similar to the test sample.

Put simply, a standard deviation describes where 68% of the fibers lie in relation to the mean fiber diameter of the sample.

Standard deviation is measured and quoted in microns.

So, a standard deviation of 4.0 microns means that 68% of the fibers within that sample fall within 4.0 micron on either of the mean.

The lower the standard deviation (often called the S.D.) the more consistent the micron in the sample.

Sometimes the expression ‘two standard deviations’ is used (not often though) which means that 95% of the fibers fall within the defined number of micron from the mean.

The lower the S.D. micron, the narrower and taller the graphic depiction in the histogram.

Co-efficient of Variation

Co-efficient of variation (C.V.) is a calculation designed to give an alternative method of describing evenness of micron in a sample, and allows for comparisons (between samples) that are more accurate and reliable than relying upon standard deviation alone.

For example, a standard deviation of 3.5 micron on a 30 micron AFD fiber sample is a much better reflection of evenness than the same standard deviation on a 15 micron sample where 3.5 micron represents a much larger proportion of the mean.

C.V. allows a breeder to look at like animals and compare them within a herd under the same management and environmental conditions.

In general, stronger micron fleece reflect a better C.V. than finer fleeces so breeders should be wary of expecting low figures for finer fleeces.

Exceptional finer fleeces will reflect low coefficients of variation with figures under 20% being highly desirable and reflective of superior fleece.

Comfort Factor

Generally speaking, fibers stronger than 30 micron create a prickle sensation when worn against the skin.

In the past, the alpaca industry reported this negative aspect of the fiber as prickle factor and described it as the percentage of fibers over 30 micron within a sample.

In marketing terms, prickle factor was considered to be a huge negative as it (accurately) created a negative connotation of the fiber. Following the Australian wool industry example the negative was turned into a (more) positive by describing the same trait in terms of comfort factor which is the percentage of fibers under 30 micron. Approximately 95% of people will experience a prickle sensation from yarn worn against the skin where more than 5% of the fibers are over 30 micron. This same negative is now described as a comfort factor of 95% when the sample has 5% of fibers over 30 micron.

Curvature

Some test results will indicate a measurement described as curvature. This is the degree by which the fiber moves from the straight line in a specific distance.

Straight fibers, like suri, have a very low degree of curvature because the fiber does not change direction along its length. Conversely, high frequency, highly crimped fibers will show high degrees of curvature.

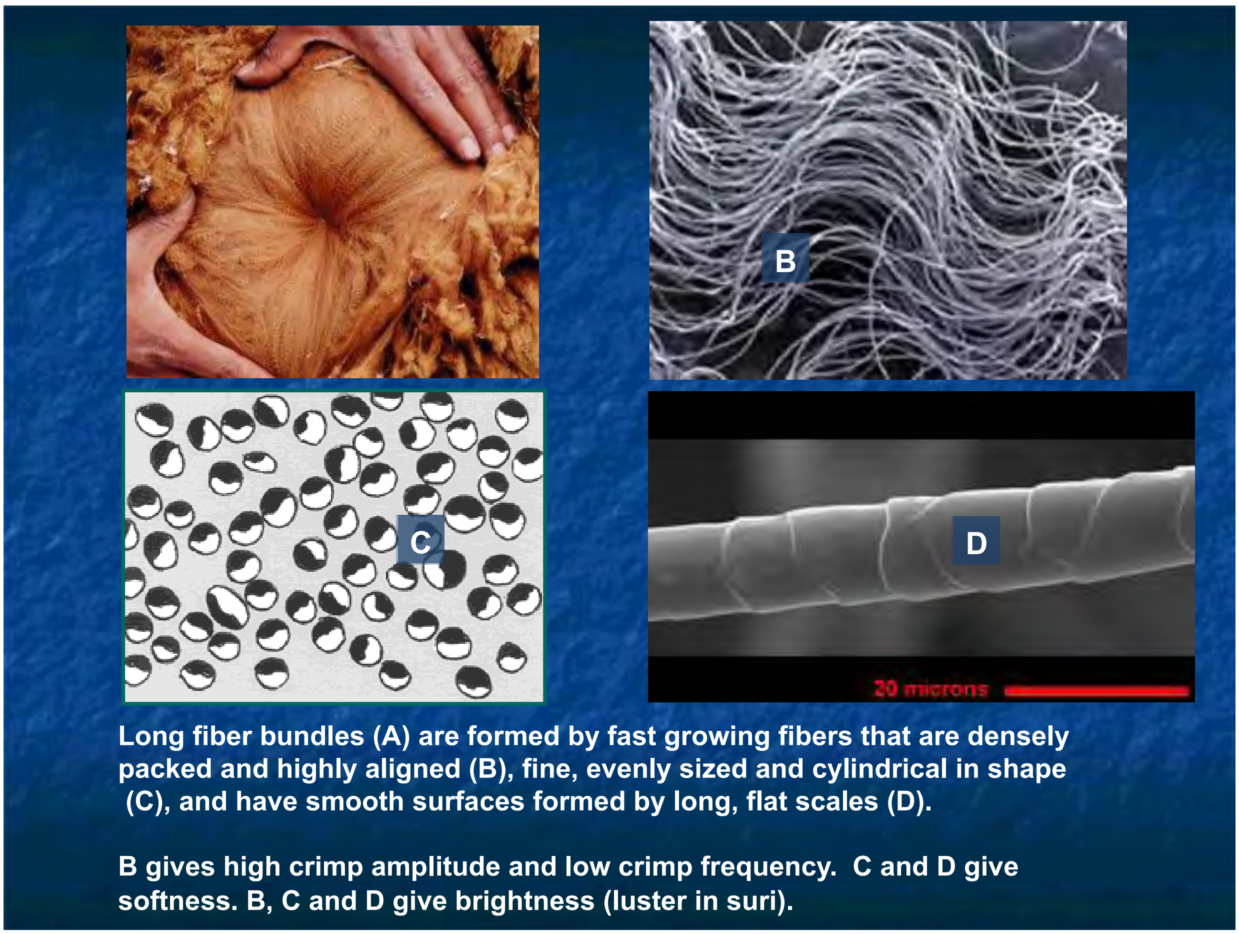
It is suggested that curvature is an important indicator in defining the processability of fiber but it has also been suggested that this is not as important in alpaca as it is in wool, primarily because there are many more production and quality traits that need priority at this stage of development of the alpaca.

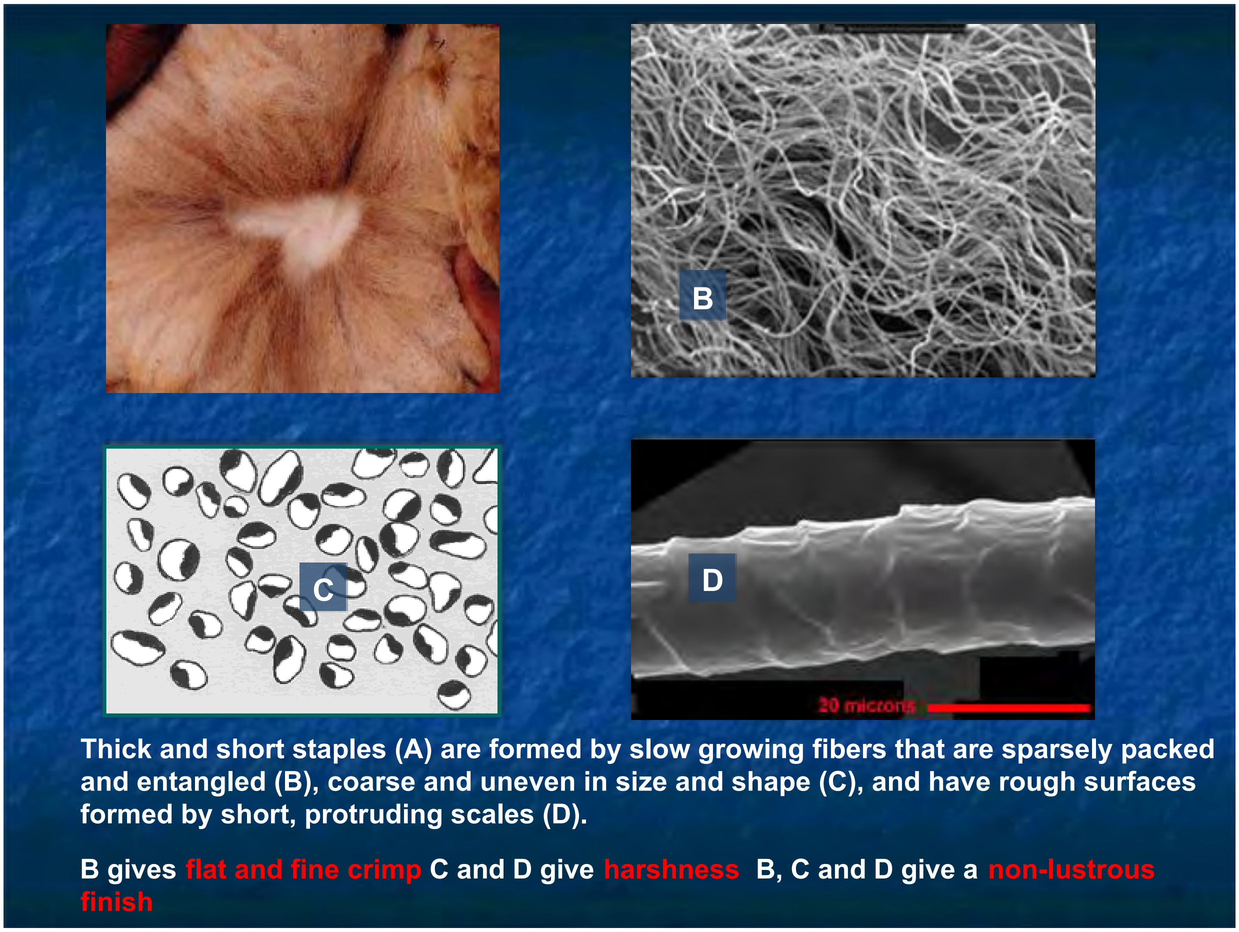
OTHER PRACTICAL CONSIDERATIONS

Handle

Handle is the term used to describe the sensation felt when 'handling' the fleece – it is the feel of the fiber in the fingers, the softness, the evenness and, in suri in particular, the silkiness.

In essence, handle is the evenness of the individual fibers as felt by the fingers, within the sample being felt. In most animal species, poor handling fiber is mainly related to unevenness of the individual fibers within the sample. In wool it has been suggested that dense fleeces are comprised of near perfectly round individual fibers with less dense animals exhibiting uneven shaped fibers.





When running these samples through the fingers, the sensation is of unevenness of individual fibers in both shape and micron.

Of course, dust and vegetable contamination will also affect the sensation as will the condition of the skin on the fingers and hand.

Experience shows that darker fleeces in the higher microns quite often 'handle' better than many of the lighter colored, finer fleeces.

Standard deviation and/or co-efficient of variation are as close as objective measurement will describe handle but nothing measurable will describe the pure sensation of handling an elite fleece.

Color

In the commercial world, color represents a problem for processors, which they would prefer not to have.

The commercial reality is that the world demand in alpaca is overwhelmingly in white fleece, with black being important but on a much, much lesser scale.

In the American alpaca industry (in particular), color is hugely important in the showing and marketing of alpacas.

Color is very much in the eye of the beholder and very much a preference issue for individual breeders.

In general, colors are stronger in micron as the color darkens away from white. The same could, in very general terms, be said for density and, perhaps, staple length.

As a general rule, solid colors are much preferable to mixed colors as minor colors in a fleece offer problems of contamination with a subsequent downgrading of price on offer.

Bundling

The term ‘bundling’ was introduced by Dr Jim Watts to describe what a truly dense fleece staple looks like to the eye – until that time wool growers had bred for thick staples that stood erect from the skin.

Selecting for bundling means selecting for staples that droop from the skin and are small in nature – in fact, the smaller the bundle the more dense the alpaca is likely to be, the longer the staple will be and the more the staple will droop or hang from the skin. In alpacas this helps when the animal rolls as the dust tends to fall out as the animal shakes and walks.

Bundling also is usually associated with high definition crimp and brightness as the density creates closely aligned fibers that lock together simply because they emerge from the skin from closely aligned follicles. Bundling does not appear to be as prevalent in animals where staple length has not been a high selection priority – selecting for density and length creates bundling.
Note: alpacas are densest as cria and settle down at optimum bodyweight to a lower number of follicles per unit area.

Long fibre bundles indicate high levels of fiber density and length