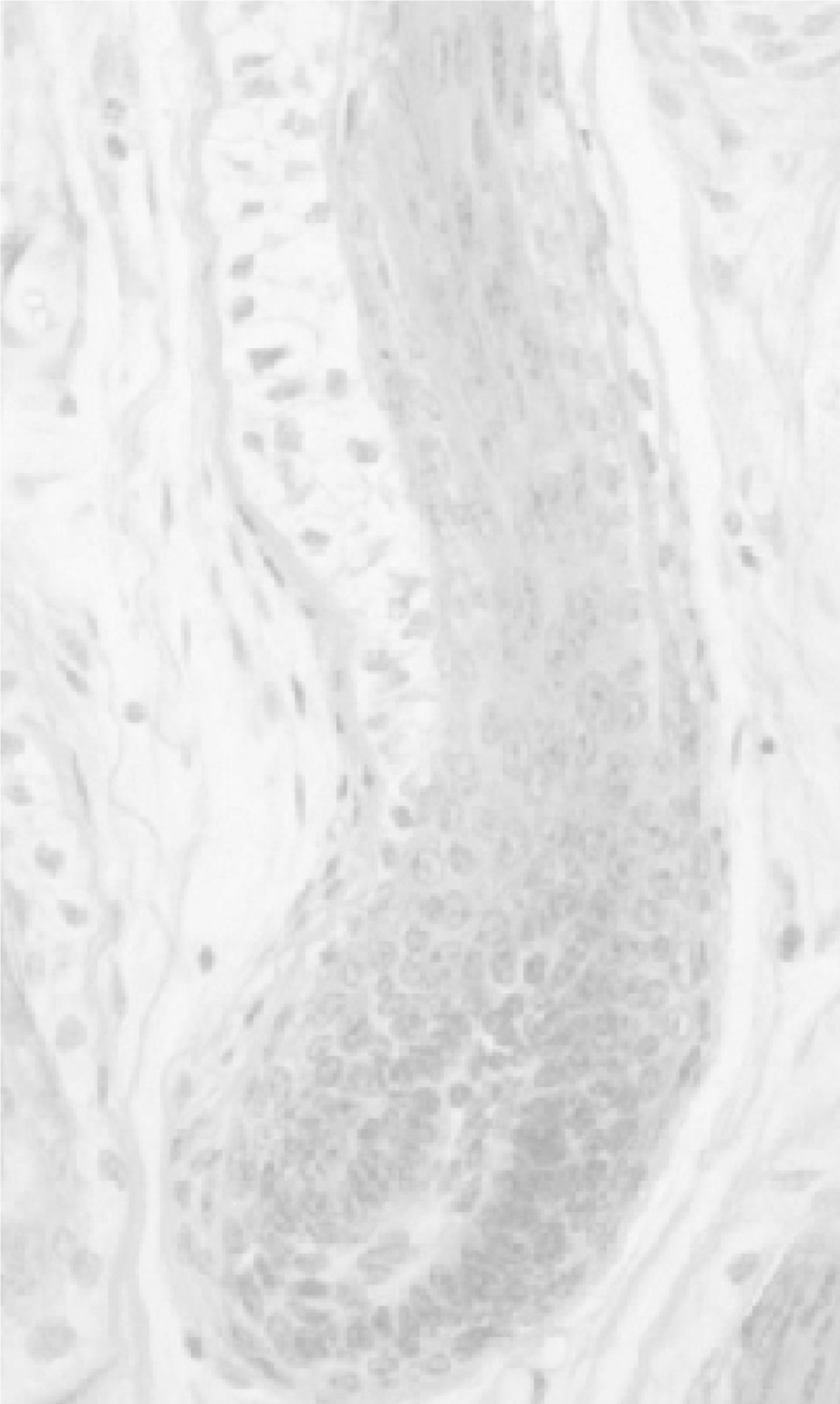

Alpaca Fibre

AN INTRODUCTION

Book Chapters

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This booklet is an introduction to a better understanding of what is alpaca fibre, how it grows and how breeders assess it. It is the first in a small series of booklets about various aspects of alpaca fibre, with the next edition concentrating on a breeding strategy to achieve elite fleeces, and understanding the genetics of fibre trait inheritance.

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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 fibre.

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 fibre 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 fibres. In the show-ring, fibre comprises 50% of the animal evaluation in the United States of America and 60% in Australia – the two largest alpaca populations outside South America.

Most breeders extol the virtues of the fibre 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 fibres.

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 fibre.

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 book 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 better informed, learn something new and are more successful as a result of reading this book, then I am content!

Ian Watt

Chapter 1

What is alpaca fibre?

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 fibre. Whatever the name, it will be identified as fibre (the English spelling) in this text.

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

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

As a further complication, some fibres are medullated, some partially medullated whilst most are solid. Medullated fibres are hollow to varying degrees and are usually straight, the most obvious being the primary fibres, which create the 'halo' often seen on younger animals in particular.

Medullated fibres are stronger in micron than solid fibres and are responsible for the harshness found in some fleeces as well as a sense of prickliness when worn against the skin.

> **Authors note:** I have made a conscious decision to use Australian wool industry terminology where it fits with similar or identical alpaca fibre characteristics in preference to establishing a new set of descriptors that can only confuse international traders in alpaca fibre – our customers of the future. As much of our information on alpaca fibre 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.

Colour

In the commercial world, colour 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), colour is hugely important in the showing and marketing of alpacas.

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

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

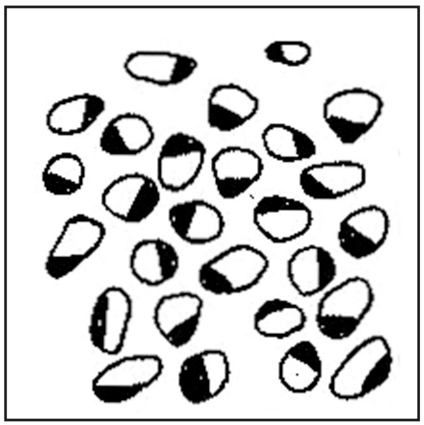
As a general rule, solid colours are much preferable to mixed colours as minor colours in a fleece offer problems of contamination with a subsequent downgrading of price on offer.

OTHER PRACTICAL CONSIDERATIONS

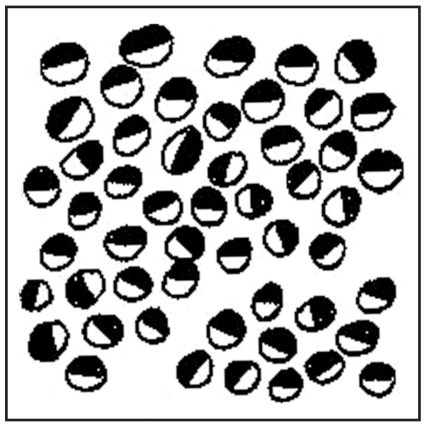
Handle

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

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



LOW DENSITY
Irregular shape, stronger micron



HIGH DENSITY
Regular shape, finer micron

When running these samples through the fingers, the sensation is of unevenness of individual fibres 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 coloured, 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.

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

These colours are further divided into light, medium and dark for the fawn, brown and grey colours 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 colour of beige sitting between white and fawn. More recently, a new colour, roan, has been introduced into he show circuit in the United States.

In South America the colour of preference is white, which probably explains why most superior fleeces throughout the world are white in colour. South American processors recognized that the world demand was for white fibre 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 fibre to take all colours 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 colour, and consistency as a whole.

Chapter 2

COMPOSITION OF THE FIBRE

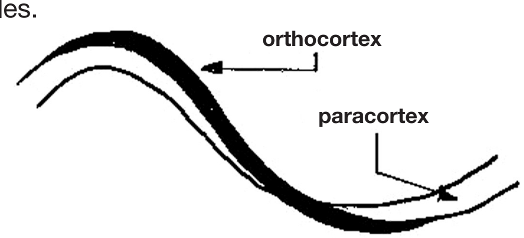
Alpaca fibre is composed of three primary parts:

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 fibre 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 fibre 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 fibre 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 lustre. The scales differ in length and height, which affects reflective ability more commonly referred to as lustre.

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



It is interesting to observe that as fibre diameter increases, the frequency of crimp decreases which is caused by a movement in the percentages of ortho and para cortical cells in the fibre. 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 fibre 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.

Curvature

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

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

It is suggested that curvature is an important indicator in defining the processability of fibre 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.

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 fibre 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 co-efficients of variation with figures under 20% being highly desirable and reflective of superior fleece.

Comfort factor

Generally speaking, fibres 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 fibre as prickle factor and described it as the percentage of fibres 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 fibre. 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 fibres under 30 micron. Approximately 95% of people will experience a prickle sensation from yarn worn against the skin where more than 2% of the fibres are over 30 micron. This same negative is now described as a comfort factor of 98% when the sample has 2% of fibres over 30 micron.

FIBRE TYPES WITHIN A FLEECE

Primary fibres

These are the fibres around which follicle groups form 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 fibres usually appear in young alpaca (named ‘cria’) as a halo effect, which, in lighter coloured animals, becomes less noticeable as the animal ages.

Primary fibres are usually stronger in micron and have little or no crimp in the staple or lock and no crinkle as an individual fibre.

Interestingly, as density increases so the primary fibre 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 fibres.

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 to 40 micron in young animal fleeces. As animals age, the fibre naturally strengthens in micron heading toward the upper limit of the primary follicle micron count.

Secondary fibres

Secondary fibres make up the undercoat or down of the fleece and are the finer, softer fibre that gives alpaca its luxury feel and improved insulation attributes. These fibres gather around the primary fibres to create follicle groups with the more secondary follicles to primaries creating finer, softer and more uniform fleeces. These fibres 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 to lower frequency and higher amplitude in others.

Individual fibres exhibit a characteristic called crinkle which are irregularly spaced variations in the direction which the fibres 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 fibres to see the change – the crimp disappears and what is seen is a fibre not straight, but with changes of direction along the length.

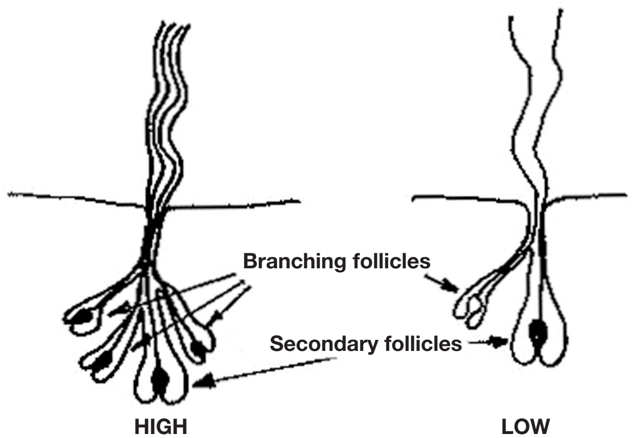
Derived secondary fibres

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

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

They are highly desirable fibres.



Medullated fibre

Many people, including alpaca breeders, confuse medullated fibre with primary follicle fibres.

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

These are the more insidious fibres 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.

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 1.6 micron. In other words, a fleece of 20 micron cannot be said to be finer than one of 21.6 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 fibres lie in relation to the mean fibre 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 fibres within that sample fall within 4.0 micron 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 fibres 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.

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.

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 minimum length for superior fibre processability for top-end retail product. In Australia, the classing of fibre lines by length identifies 120-150mm (5 to 6 inches) as premium length followed by 80-120mm (3.5 to 5 inches) and then 60-80mm (2.25 to 3.5 inches) with lesser lengths having no commercial value.

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 fibres with a thickness exceeding 30 micron causes a prickle sensation when worn against the skin. It follows then that very fine fibre 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. With the advent of lasers, measurement of fibres 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 is stronger in micron.

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

Medullated fibres 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 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 is adopting the more acceptable 'comfort' factor descriptor. Comfort factor is defined as the percentage of fibres over 30 micron based on research in the Australian merino wool industry that showed human discomfort when fibres 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 fibre 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 fibre with its hollow nature being the reason that alpaca fibre 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 fibres 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 fibres is far, far less than that gained from the trapped air between the fibres in the finished product.

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

Chapter 3

HOW FIBRE GROWS

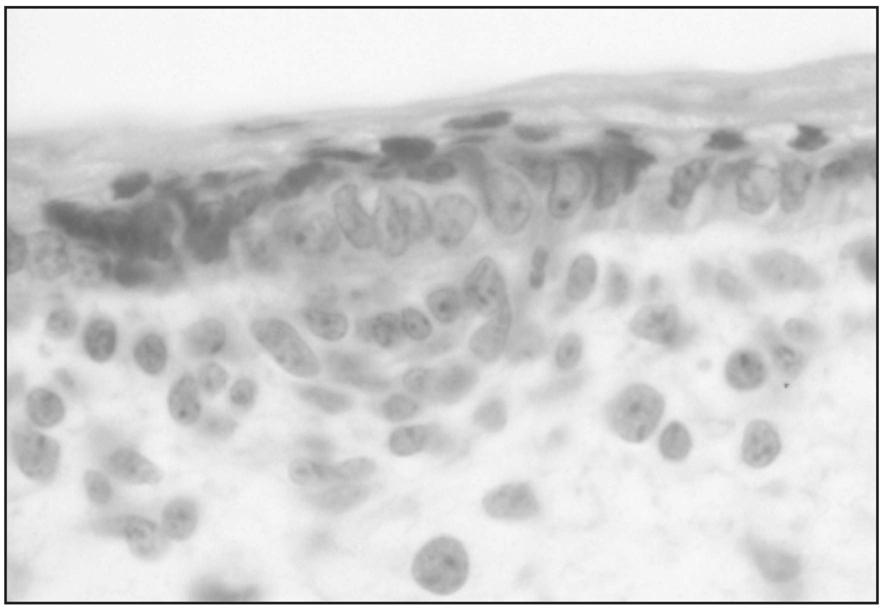
Follicle formation in the skin

Many fibre coated animals share a common expression of fibres in the skin. Alpacas are no different and form their fibre follicles in groups developed around three primary follicles. It follows then that to get more follicle groups, there must be more primary follicles. Therefore, to select, and breed, against primary fibres 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. Fibre is expressed from the skin during the last trimester of pregnancy.

The skin comprises the epidermis (the outer layer) and the dermis, the under layer.

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



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

UNDERSTANDING OBJECTIVE MEASUREMENT OF FIBRE

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 fibre sample.

The histogram represents the distribution of the number of sample fibres according to their individual micron count and their numbers for each micron count. Plotted on a standard graph base with numbers of fibres 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 very 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.

Chapter 4

ASSESSING FIBRE – BY TECHNOLOGY AND BY HAND

The assessing of alpaca fibre 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 fibre) often at the expense of uniformity of length, colour and definition, all of which are important considerations when assessing quality.

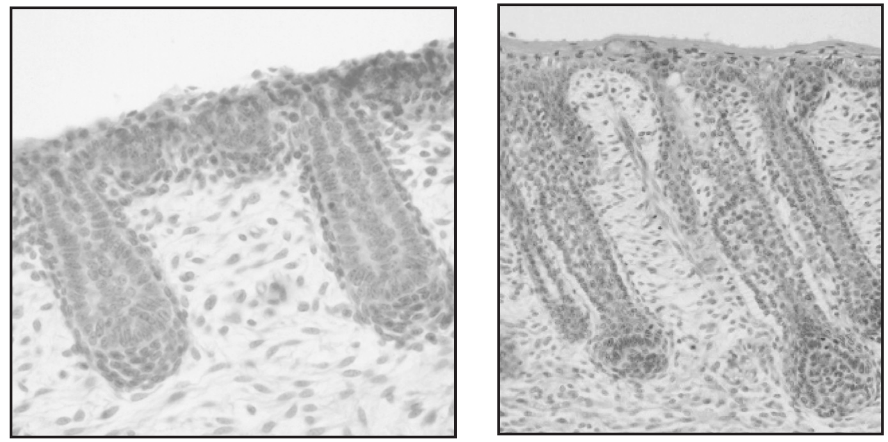
> **Successful breeders will utilize objective measurement data as part of their arsenal of selection tools, which will also include the use of both their senses of touch and visualization.**

Alpaca fibre 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 (lustre in suri), crimp and colour.

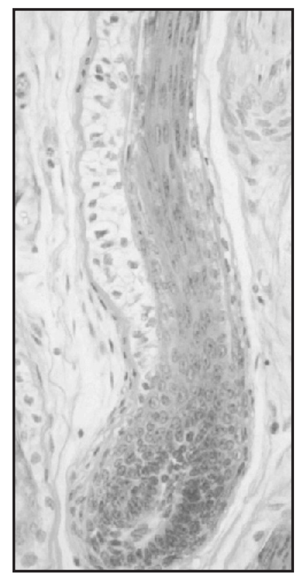
Objective measurement should never be the sole arbitrator in the decision making process but it should be an essential part of the breeders decision making toolkit.

Chemical messages cause a proportion of these fibroblasts to convert into prepapillae 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 epidermal cells engulf the pre-papilla cell clusters.



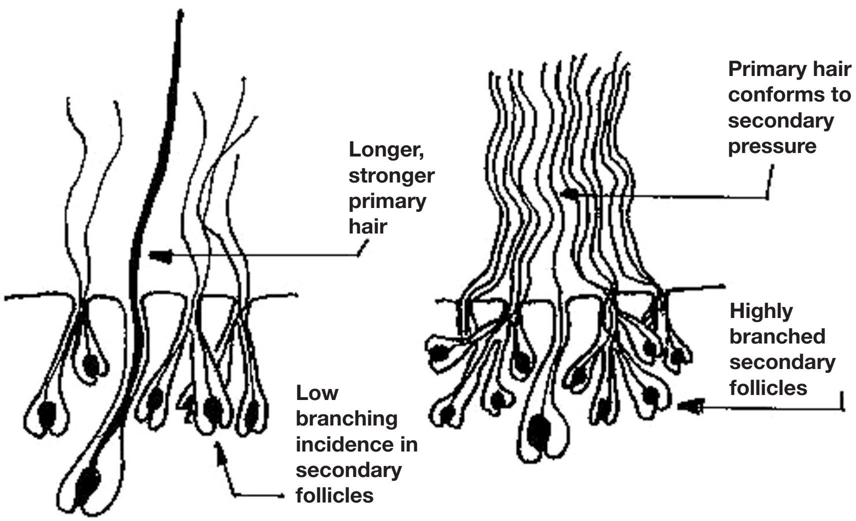
The pre-papilla cell cluster now forms the dermal papillae at the base of the wool follicle.

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 fibre 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.



LOW DENSITY FOLLICLE GROUPING **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 fibre density some breeders notice after the first shearing.