THE SPIN ON SURIS AND HOW THEY DIFFER FROM HUACAYS

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INTRODUCTION
Alpaca’s come from the Genus Llama family, which also include, Llamas, Vicuna and Guanaco. They come under the umbrella of the Camel family, their old relations. The Alpaca and Llama it is thought has descended from the Vicuna and Guanaco.

THE SURI DESCRIPTION

Fineness 18-35 microns (has a soft silky feel)
Length average 100-200mm (4-8 inches) in 12 months
Fleece weight 1.5-4.5 kgs (3-9 lbs)
No crimp (straight fibre). The fleece has curly staples
Lustrous
Medullation (less visual guard hair types)

The Suri should grow a very lustrous silky dense fibre, which hangs in individual locks, vertical to the body (similar to that of a mohair goat). These locks come in various types, with the ringlet formation and the wave with twist being the most popular.

Although the face is open it may be covered with short fine lustrous fibre. The topknot area of a suri grows fibre, which hangs down, similar to a fringe over the forehead, falling down onto the face. The style/character in the fleece should be maintained from the forehead all the way down through the body to the lower leg.

There will be an increase in micron in the apron area. Guard hair (Medullated fibre may also be found in this area (suri fibre contains less medullation than huacaya).
CONFORMATION
The ideal functional Suri should be correctly balanced and proportioned (squared off appearance) displaying a proud and alert presence and should “walk tall”

GOOD
The neck should be approximately 2/3 of the length of the backline with the legs being approximately the same length of the neck. The legs should, when viewed from the front and rear, appear relatively straight. When viewed from the side the front legs should be relatively straight with the rear legs slightly bent. (slightly sickle hock)

POOR

FIBRE TYPE
True to type suri fibre will be dense to feel and will have a cold sensation when handled. The bulky intermediate fleece type, sometimes associated with cross breeding, will have an average density and will be warmer to touch. It is quite noticeable the difference between the two types as the true to type suri will hang close to the body, giving the illusion that the suri is thin, whereas the intermediate type will be more rounded giving a fatter appearance.
EVENNESS

Very even across the body

Varies from neck to britch

The fleece should even from head to lower leg and front to back.

INDEPENDENCE OF LOCK

The locks should be independent and free flowing.
Suri does not exhibit any crimp but is a relatively straight fibre in comparison to huacaya. A very low wave/twist is desirable when looking at the individual fibre as compared to a very straight fibre.

A hybrid type sometimes referred to as a “chili” or “huasu” is highly lustrous exhibiting a broad crimp like structure and grows in a suri lock like formation. This fibre is undesirable in suri.

The Alpaca population comprises of approximately 94% Huacaya and 6% Suri.

Alpacas have upwards of 20 recognised grades of colour.

ALPACA IDENTIFICATION AND STRUCTURE

FIBRE GROWTH

SKIN LAYERS:
Sheep’s wool and Alpaca fibre vary greatly for fibre diameter (micron), quantity and quality as well for fibre type amongst different breeds or variations of the breed (e.g. Huacaya/Suri). Variations are also found within a single fleece and within the individual staples which form that fleece.

To better understand why some of these variations occur, we will study the skin of a fibre producing animal (SHEEP) and the development of the fibre producing follicles.

Wool follicle and fibre growth originates in the skin, which is made up of layers of cells.

There are three layers:

<table>
<thead>
<tr>
<th></th>
<th>Epidermis</th>
<th>Dermis</th>
<th>Basal layer</th>
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<tbody>
<tr>
<td>1.</td>
<td>outerlayer</td>
<td>underlayer</td>
<td>Layer of cells separating The dermis and epidermis.</td>
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</table>

Fibre growth begins in the dermis. At certain positions in the skin the basal layer thickens and begins to grow down into the dermis forming a plug of cell tissue which ultimately becomes the fibre-producing follicle.

At around 60 days post conception fibroblast cells in the dermis begin to form into equally spaced clusters of committed cells called pre papilla cells. These are the cells which go to form the follicle. Undifferentiated fibroblast cells maintain their role in producing the collagen which is the main filler substance in the skin. The pre-papillae are programmed to form aggregates of pre determined numerical sizes.
These aggregates stimulate the **epidermal cells which grow into the dermis** to form the first primary follicles.

**This first plug is seen in the foetus around 70 days post conception.**

At around 80/90 days the process is repeated for the first of the secondary follicles and at 100 – 110 days the third wave of follicles, the secondary derived are formed. The secondary derived follicles usually share the same opening as the secondary follicle. There is usually 3-4 secondary derived to each secondary follicle, although the number has been seen as high as 20.

As the plug grows two outgrowths appear.

1. **Wax (Sebaceous) gland** which lubricates and protects the fibre.

2. **Sweat (Sudoriferous) gland.** These glands produce differing degrees of sweat in various animals.

This figure shows the various structures of the primary wool fibre.

Alpaca is similar to this structure.

The plug becomes bulbous and forms a dome like structure over a group of actively dividing cells in the papilla. It appears that the signals emitted by the dermal papilla regulate the cell division in the follicle bulb. The size of the dermal papilla and the dimensions of the fibre produced are closely correlated (Ibrahim and Wright 1982, Rudall 1956, Van Scott and Ekel 1958). It is suggested that the signal strength emitted by the papilla determines the fibre growth/length (Watts 2002). Moore, (1984) also suggests that the number and size of the primary follicles are strongly inherited and that if fewer and smaller primary follicles were initiated, a lesser proportion of the pre papilla cells will be used in the formation of primary follicles. Therefore, more cells will be available for the formation of increased numbers of secondary follicles.

Follicle bulb cells form the fibre and the root sheaths. It is these sheaths that mould the fibre and become harder before the fibre is keratinised (wool fibre). Keratinisation normally takes place a third of the way up the follicle canal. The growing fibre is pushed upwards through the follicle plug by pressure of new cells being formed continuously from the dome of the papilla. It eventually breaks through the skin surface. The sebaceous gland supplies wax to the fibre by means of ducts opening onto the wool follicle near the surface of the skin. This wax lubricates the fibre in its passage through the contracted portion of the skin, as well as adding protection to the fibre in general.

The process of follicle formation is established by birth although some follicles take some months to start producing fibre. It should be noted that when an animal suffers from lack of nutrition or ill health, the supply of nutrients to the follicles are reduced and the output of cells from the papilla slow down. This reduces fibre growth, fibre thickness and may cause some follicles to shut down.

**S/P RATIO 3/1**
FOLLICLE DEVELOPMENT

Each fibre is produced from an individual follicle and at birth, there are two major types:

- **Primary**
- **Secondary**

The primary follicle has a structure of both wax and sweat glands as well as an arrector muscle, whereas the secondary follicle only has a wax gland.

In sheep, follicles start to form in the foetus at approximately 60 days post conception. These are the primary follicles and the secondary follicles start to form at around the 80-day mark. Gestation time for sheep is around 5 months compared to Alpacas at approximately 12 months.

(Holt)

In sheep these follicles tend to develop in groups of three (trio) primary and associated secondary fibres.

Dr Jim Watts (1996) has found in a group of Alpacas similar "trio" groups to that of sheep.

They had S/P ratios (secondary/primary) of 16.5/1 to 3/1 averaging around 7/1. His research also indicated in mature alpacas, average follicle densities of around 24 follicles per square mm with measurements up to 60/70 follicles per square mm.

Average SP Ratios, Fine Merino Sheep 30/1
Corriedale Sheep 14/1

FIBRE STRUCTURE

A complex protein called Keratin forms the composition of the fibre. Keratin is composed of the elements, carbon, oxygen, hydrogen, nitrogen and sulphur.

The fibre itself is a complex assembly made up of an innumerable number of cells. The fibre consists entirely of rounded elongated and spindle-shaped cells, thick in the middle and tapering away to a point at each end.

Basic cellular structure INSIDE (CORTICAL)

The OUTER CELLS (CUTICLE) are hard flattened scale-like cells which do not fit evenly together. The edges of these cells protrude from the fibre shaft giving the fibre a serrated edge (SERRATIONS).

Serrations are an aid during processing as they help the fibre grip together to form a strong yarn. These are a greater aid to huacaya fibre than suri.
OUTER CELLS (CUTICLE)
Microscopic examination of the scale pattern enables us to identify groups of similar fibres. Micron, scale frequency and scale height can be measured using this technique.

Research has shown that the cuticle cells on wool fibre protrude approximately .8 micron from the shaft whereas Alpaca and Mohair protrude approximately .4 micron.

Villarroel (1959) also observed a difference in scale heights between wool and Alpaca but suggested the differences became less with the finer fib

It would therefore be simple to conclude that the softness of Alpaca, of a given micron over that of wool of the same micron, is due to the scale height (protrusion). Having been able to identify the wool from Alpaca due to this scale height we may need to go to the scale frequency of Alpaca to distinguish it from mohair. Mohair had a frequency of 6 - 8 compared to Alpaca (huacaya) that had a mean frequency greater than 9 (per 100 microns). Villarroel suggests that cuticle cells of the Huacaya protrude slightly more than the Suri, This is demonstrated in the photos below.

The Suri fibre having less cuticle cells than the Huacaya, makes the Suri more slippery to feel and more lustrous than the Huacaya. Tillman (2006) found that the mean scale frequency of Suri was 6.5 scales per 100 micron. Mohair has a frequency of 6 - 8 similar to Suri. Huacaya has a mean frequency around 9 - 11 (per 100 microns)
CORTICAL CELLS

Cut away sketch of a fine huacaya fibre showing the major components of the cortical cell.

As you can see the fibre has two cortical cells. Para and ortho. In certain coarse fibres a hollow core may be visible (medulla).

UNDER THE MICROSCOPE

Villarroel (1959), Holt (1994) found that Huacaya Alpaca (not Suri) like wool has a clearly defined ortho-para differentiation in the crimped fibre (fine). In the Suri fine fibre no visible bilateral demarcation was evident. However Holt (1997) found a difference in the cortical cells in the outer edge of the fibre of suri tight ringlet fibre (above right). This was similar to Maddocks et al (unpublished) findings in the ringlet type of mohair fibre.

HUACAYA / SURI FIBRE DIFFERENCES

The first difference found between Huacaya and Suri is in the internal cortical cells of the fibre. The Huacaya has a bilateral structure (not unlike sheep) and the Suri does not. Villarroel (1959) and Holt (1994) identified this. Bilateral structure is made up of the orthocortex and the paracortex. These cells grow in their groups next to each other. (see previous photo, cortical cells).
The bilateral formation is responsible for the crimp/crinkle in the Huacaya. Research in 1953 by Japanese scientists found that the orthocortex was always observed on the outside of the crimp curve.

Because the Suri has a helical coil structure (like mohair) the fibre is relatively straight.

The Suri fibre has less cuticle cells (outside cells) than the Huacaya (over a given length, EG 100microns). Hence the Suri is more slippery to feel and more lustrous than the Huacaya.

Stapleton – (1992) said,

"The cortical cells in Alpaca fibre constitute a variable fraction of the fibre mass, being lowest in coarse and highest in fine fibres where the fraction may be as high as 90%. Cortical cells are the load-bearing elements of the fibre, whereas the cuticle imparts the inherent aesthetic qualities of the fibre such as softness of handle and lustre. Other functions of the cuticle concern water repellence, felting during washing, and resistance to chemical and physical attack. The entire assembly is held together by a glue call intercellular cement."

The follicle formation of the Suri is like that of the Huacaya in the skin, but due to different structure of the cortical cells has a different appearance in its lock formation. The Huacaya has a crinkle like appearance in its fibre growth and in the staple (lock) a crimp (like a small deep wave) forms.
HUACAYA
Huacaya has a wave or corrugated appearance known as a crimp.

SURI
The Suri fibre grows basically straight, and locks may have a ringlet appearance, slight wave with twist or can be quite straight.

HUACAYA (X120)     SURI (X120)
(photos-Holt 2007)

Notice the curve in the huacaya fibres above, compared to the straighter suri fibres.

Huacaya and Suri also have processing differences due to their individual fibre structures. Suri is basically more difficult to process. Firstly the machines are set at a lower speed than for the Huacaya. The Suri fibre lacks cohesion (due to its cuticle cell structure and straightness). There is slightly more fibre wastage when processing Suri fibre.

When spinning a yarn of a smaller thickness and a given micron, there will be more fibres required in a Suri yarn than that of a Huacaya. This is due to the straightness of the Suri compared to the crinkle in the Huacaya, which gives more bulk. The Suri yarn would therefore be heavier.

Not surprisingly, measurements for fibre curvature in the Suri were much lower than that of the Huacaya. Curvature in Suris tended to give a range from 15 to 35 with the Huacaya showing a range from 25 to 60. (OFDA)

It was noted that the coarser the micron, generally the lower the curvature value. Also when the C of V was more variable (higher) the curvature value also tended to be lower.
Data from Australian Alpaca Ass data bank was examined for micron and curvature.

With a good spread of fibre type in the 1603 white huacayas, the data indicated that there was a 48% unexplained variance (.72 correlation). curvature value gets smaller.

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

As the suri breeding becomes more advanced this correlation should improve as the range of fleece types becomes more uniform.

NOTE
Care should be taken when comparing results from LASER and OFDA machines  A difference of approx 17.8 deg was found in a trial of huacaya (Holt/Davison 2004)  OFDA – ave  35.58 LASER – ave  53.39

Research by the writer has found that the spread of micron (evenness) over the Suri is similar to that of the Huacaya. Co efficient of variation for micron, prickle factor, was also similar.

Medullation in the Huacaya was greater than for the Suri fibre.

<table>
<thead>
<tr>
<th>Micron</th>
<th>Huacaya</th>
<th>Suri</th>
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<tbody>
<tr>
<td>20</td>
<td>12.9%</td>
<td>4.7%</td>
</tr>
<tr>
<td>26</td>
<td>36%</td>
<td>16%</td>
</tr>
<tr>
<td>36</td>
<td>60%</td>
<td>42.4%</td>
</tr>
</tbody>
</table>
Alpaca fibre depending on micron, has some medullation. The medullated types are defined into 5 categories.

(1) Non medullated fibres, 15-20 micron diameter
(2) Fragmented, 20-30 micron diameter
(3) Interrupted, 30-40 micron diameter
(4) Unbroken medium wide, 40-60 micron diameter
(5) Unbroken very wide (near to lattice type), 60 or more micron diameter

Group "5" is undesirable in Alpaca fleece.

LACK OF GUARD HAIR

The medullated fibres called “guard hair” are not desirable in the finished product. They are stiff and hollow with pointed tips. They reflect light differently to solid fibres and are hard to control when spinning. Medullation (guard hair and continuous medulla) is also considered a disadvantage because of fibre breakage. Partial fragmented medulla has little affect on fibre tenacity. Medullation (guard hair) also creates non-uniformity of colour levels in the dyed fibre. A large number of these fibres are removed during the carding/combing process but a number still remain and these are a contributor to the coarse edge, which gives the “prickle factor” (now known as the “comfort factor”) in garments. Being stiff they will protrude from the yarn.

Breeder's can measure the numbers of medullated fibres including those partially medullated, using an O.F.D.A. (white only). A Histogram of medullated fibres is superimposed over the solid fibres and records the various diameters and spread. Dark coloured fibre is more difficult to calculate and results for these colours are not as reliable.

As noted before, medullation in Suri appears lower than that of similar microns for Huacayas. (Holt/Scott 1998). It was noted that as the fibre became stronger in micron there was an increase in medullation.
TRUE TO TYPE SURI FIBRE

There is much discussion on what constitutes a true to type Suri (pure). Just because the two parents are “Suri looking” does not mean the Suri progeny is true to type. It will depend on

- pureness of parents and lineage
- correctness of lock type and style
- trueness to breed type

Many “Suris” coming from South America have no traceable ancestry. They may be from a homozygous male and a Huacaya female (let alone a heterozygous male). The Suri could look relatively true to breed but have a questionable fleece type.

There is an old saying

“If it looks like a duck and walks like a duck it is a duck”

But, how many Suris “look like a Suri and walk like a Suri, but when you open the fibre they are not as true to type as you think.

TRUENESS TO TYPE

**Trueness to Breed**

Displaying characteristics laid down for a specific breed of animal. Possessing the most desirable characteristics of the breed (correct fibre type). A suri with straight plain fibre and chalkiness (no lustre) would be said to be “not true to breed”.

**Trueness to Type**

A term used more by buyers and processors. It reflects the trueness to the actual requirements of manufacturers of alpaca fibre. EG Fibre which is even and regular within the specifications of a certain type. (impurities have an effect on this evaluation).

Example: Fleece exhibiting the best of all its characteristics and free of vegetable matter would be considered to be “choice or extra super style”, whereas a fleece with a lot of dust and vegetable matter and poor in all its characteristics would be considered “poor or inferior style”.
A paper by Dr. Mick Carrick (1996) suggests that the Suri is dominant over Huacaya. His findings are similar to Dr. Raul Ponzoni (1997). Ponzoni, based on research in Australia, hypothesises that of a single gene with the Suri dominance over Huacaya. He found when Huacaya was mated to Huacaya it gave 145 Huacaya progeny with no Suris. Based on his hypotheses he assumed that the Huacaya gene was recessive. Where a Suri male was used over Huacaya females, there were 13 Huacaya and 11 Suri progeny. This fits the hypotheses of Suri dominance if that male was heterozygous. When Suri males were used over Suri females, the result was 6 Huacaya and 29 Suris. This was consistent with the Suri used being heterozygous.

Carrick in his paper concludes that the same results (as the Hypotheses of a single gene) could be obtained by a group of very closely linked genes.

Suri genetics can be demonstrated with simple models based on probable outcomes.

Example:

\[
\begin{align*}
SS & \quad ss \\
(Suri \text{ Homozygous}) & \quad (Huacaya \text{ Homozygous}) \\
Ss & \\
(Suri \text{ Heterozygous})
\end{align*}
\]

Anecdotally it appears that the better the Suri male and Huacaya females then the better the Suri types on the ground.

When a heterozygous Suri male is used over Huacayas the following appears.

\[
\begin{align*}
Ss & \quad ss \\
Ss & \quad Ss \quad ss \quad ss \\
(2 \text{ heterozygous Suris and 2 homozygous Huacayas})
\end{align*}
\]

The writer has seen a number of these crossings and has noted that the fibre type varies. The fibre type appears to range within each breed group.
The other possible result is the mating of Suri to Suri. Using a homozygous male over heterozygous female or vice versa

SS    Ss
     |
SS  SS  Ss  Ss

(All look like Suri but 2 are homozygous and 2 are heterozygous)

Using heterozygous male over a heterozygous female

Ss    Ss
     |
SS  Ss  Ss  ss

The result would be

1. Homozygous Suri
2. Heterozygous Suri
1  Homozygous Huacaya

So how do we know when the Suri is homozygous. Just because they come from Peru or Bolivia does not make them homozygous as many have found out.

If you test mate your Suri male to 15 Huacaya females the result should be all Suri progeny (if the suri is homozygous). One or more Huacaya would indicate a heterozygous male. Unfortunately we cannot lift up the tail for an answer.

A very good example of "percentage of Suri blood" can be seen in a breeding scarla diagram by Dr Pierre Baychelier. Here there is one Huacaya and 7 pure Suris involved in the example
**Pedigree of a backcross 3**

The figures in % represent the percentage of suri blood
(H huacaya, S pure suri, F1 first filial generation, BC 1 backcross 1, BC2 backcross 2, BC3 backcross 3) – F1, BC1, BC2 and BC3 exhibit the suri phenotype.

(Reproduced with permission of Dr Pierre Baychelier)

From a purely personal point of view, I believe that cross breeding is a legitimate form in any breeding program. It was used in Australia in the Angora goat industry when there were few pure Angora goats available and it was also used when upgrading cashmere goats although the cull rate in the cashmere program was up to around 70 per cent. Cross breeding was also used to breed carpet wool sheep where the matings of Tukiedale and Romney Marsh sheep were used. The Tukiedale is the dominant gene similar to the suri, but the fibre was predictable unlike suri. I think it is fair to say the sooner we can breed with some trueness to breed type, the sooner the predictability of the progeny can be made.

The importance to me at this stage is not so much the genetic pureness, which we can estimate, but are the “pure” Suri progeny true to type?

I would strongly recommend that all males that are not true to type should be culled from the herd and castrated.

**WHAT ARE THE MAIN TRAITS FOR SURI FIBRE**

The main trait is **LUSTRE**

Good lustre is the most important characteristic for Suri fibre as this is what is required in a finished garment of Suri or Suri blend yarn. It is therefore important for the breeder to be able to identify chalky type fleeces and either breed this fault out or sell the animals concerned. Breeders should record fleece as,

- High
- Good
- Average
- Dull/Poor (Chalky)
MEAN FIBRE DIAMETER is one of the main attributes. This is expressed in microns (1 micron = 1 millionth of a metre) and is a most important characteristic of any fibre. The micron determines the fineness of the yarn and when using fine micron fibre, soft lightweight fabrics can be produced.

Micron accounts for approx. 70/80% of the value of alpaca fleece.

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 eg. wool or processed by itself.

HANDLE AND SOFTNESS (closely linked to fineness) are in my opinion one of the main assets of Alpaca fibre. The softness is usually due to the micron of the fibre but when comparing Alpaca with wool we have a major difference. The cuticle cells (outer) on wool protrude approximately 0.8 of a micron (scale height) compared to Alpaca that protrudes approx. 0.4 of a micron. This gives a feel of around 2/3 microns finer (softer) than the equivalent micron in wool. With lustrous Suri fibre you can get also a more slippery feel due to the scale frequency per 100 microns being lower, and with superior fibre being cylindrical. These characteristics are advantageous to Alpaca not only from the softness angle but also from the ability to wear Alpaca fibre on the skin. You would assume that the prickling factor which applies to wool with 5% of fibres over 30 microns, may not be as severe on the equivalent Alpaca fibre, although if the yarn has a lot of coarse fibres through it this may not be the case. Coarse fibre ends touching the skin triggering pain receptors just below the epidermis layer cause the prickling factor. A low CV fibre usually has fibres more similar in fibre thickness, therefore being softer to handle.

STYLE
Suri fibre is basically a straight fibre and is used like mohair for specialised fibre production. One of the main difficulties when processing Suri, (like Mohair), requires some twist in the sliver so it will not pull apart during the drawing process. This is due to the lack of cohesion when spinning caused by the low, smooth cuticle scale structure. Processors have suggested that they prefer a fibre with a slight wave in preference to a straight fibre. From a breeding perspective, Dr Julio Sumar would prefer the ringlet type followed by the lock with twist and wave.

Many variations of suri lock type exist. However, in the USA and Australia five types are commonly identified. These range from a tight ringlet, wave and twist ringlet (sometimes known as curled ringlet), corkscrew ringlet and large wave with broad lock. These four would be the most common of the five types with the other one being and a straight fibred lock.
1. The lock twists into tight ringlets almost to the skin.

2. The lock grows showing a small wave with twist. It also grows in a ringlet formation. The best locks will almost twist and wave to the skin.

3. The lock grows in a corkscrew like curl. It also grows in a ringlet formation. The lock can be small or large.

4. The large wave with the flatish broad lock is a much thicker looking lock than the above three. The thickness does not necessarily mean density.

5. The fibre grows straight showing no signs of ringlet, wave or curl.

Within the above four main types many variations can be seen. These variations can be affected by the trueness to type of the fibre and can be changed, eg. fanned ringlet, when the fibre becomes excessively over long.

Another type of lock sometimes found when breeding Suris is that with a crimp like wave along the length of the staple. This is a much bolder and wider crimp/wave than found in the Huacaya fibre. This not desirable.

**STAPLE LENGTH** is also an important characteristic. Length basically controls the method of processing Alpaca (woollen or worsted), that is, the shorter length fibres will be processed via the woollen system (eg. 2"-4", 50-100mm) and the longer (4"-6", 100-150mm) by the worsted process. The mean (average) length in the top contributes to yarn strength by increasing adhesion of fibres during spinning.

*Suri fibre is all processed on the worsted system.*

It is noticeable in Peru that the processors have their machines set for different lengths compared to Australia and USA. This is due to the higher nutrition levels in the latter consequently growing longer fibre.

The process starts with,

**SCOURING**

This is the first stage of actual fibre processing. Scouring is carried out to remove the dirt, wool grease and suint. The fibre usually passes through a set of four (4) bowls during the cleaning process. Here it is washed with warm water and detergents and rinsed in the final bowl. Alpaca fibre has a very low grease content.
Drying

After washing the fibre is passed through rollers to remove the water content. The fibre then is passed through a drying system where it is dried at around 48 degrees Celsius.

Carding

This is the first stage in yarn production. Here the fibre is put through a series of rollers of different sizes travelling in different directions and at different speeds. The wire card removes entanglement of fibres caused during the scouring process (Alpaca is usually less entangled than sheeps wool due to its low scale protrusion). The fibre is partially aligned (short and long fibres) and delivers what is called a carded sliver. A large amount of the burr and seed content is removed during this carding process.

Gilling

Here the sliver is straightened and various slivers are blended together to obtain a uniform sliver of thickness and weight.

Combining

Combing is the process of removing those very short fibres (noil) and to place the fibres in a parallel formation. This produces what is called a “combed top.” During this process any vegetable matter not removed during carding is separated from the fibre. The top may also go through a further gilling process to make it more even.

Drawing

Here the “top” is passed through a set of “drafting” rollers. The front set of rollers have a faster surface speed than the back rollers. This has the effect of reducing the top thickness to a size that can be used in the spinning process. This is called a roving. This process is carried out a number of times until the desired thickness of roving is obtained.
**SPINNING**

The spinning process continues the drawing process, usually bringing the thickness down to around 35/40 fibres in the cross section. A twist is given to the fibre to give the yarn more strength.

**KNITTING or WEAVING**

Breeders should select animals that do not have short fibre growth over 12 months (compared to other alpacas on the property – if all are short you probably have a nutritional problem).

The breeder should record length. This will enable you to identify any animal not producing commercial length fibre. All you need to do is select at random 10 staples per fleece and measure with a standard ruler, and average the measurements.

**DENSITY**

This is basically not of interest to processors, but very important to breeders for total fleece production of a given animal. Density not only helps keep out vegetable matter and dust but contributes to fleece weight. Improved density is obtained by an increase of follicles in the skin over a given area.

*average density*  
*poor density*
ALPACA (Huacaya) S/P ratios and density averages compared to microns (2007)
(holt/watts/SRS AI 2007)

<table>
<thead>
<tr>
<th>MICRON HUACAYA</th>
<th>FOLLICLE DENSITY</th>
<th>S/P RATIO</th>
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<tbody>
<tr>
<td>2007</td>
<td>2007</td>
<td></td>
</tr>
<tr>
<td>&lt;18</td>
<td>56.7</td>
<td>10.5</td>
</tr>
<tr>
<td>19 – 21</td>
<td>49.1</td>
<td>10.6</td>
</tr>
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<td>22 – 26</td>
<td>43.5</td>
<td>10.1</td>
</tr>
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<td>27 – 30</td>
<td>40.0</td>
<td>9.9</td>
</tr>
<tr>
<td>31 – 37</td>
<td>36.0</td>
<td>9.2</td>
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<thead>
<tr>
<th>MICRON SURI</th>
<th>FOLLICLE DENSITY</th>
<th>S/P RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>2007</td>
<td></td>
</tr>
<tr>
<td>19 – 21</td>
<td>42.62</td>
<td>9.76</td>
</tr>
<tr>
<td>22 – 26</td>
<td>33.47</td>
<td>8.87</td>
</tr>
<tr>
<td>27 – 30</td>
<td>27.72</td>
<td>7.58</td>
</tr>
<tr>
<td>31 – 37</td>
<td>24.72</td>
<td>6.60</td>
</tr>
</tbody>
</table>

CLEAN FLEECE WEIGHT

This is of great commercial value to the breeder. The more weight of a given micron the more return in dollars. The processor pays by the LB/kilo and is not worried how many animals it takes to produce the weight.

Fleece weight is a most important factor in your breeding program as you need to identify those animals which are below the herd average as well as identify those superior animals with top fleece weights.

Fleece weights and micron are traditionally, in the goat and sheep industry, two of the important selection characteristics along with conformation of course. Clean fleece weight is affected by –

Micron
Staple length
Follicle depth (related to staple length)
Follicle density
An example of using these two characteristics in your selection based on your goals may be demonstrated below.

Your goal is to breed 2YR adult suris of finer than 24 microns and total fleece weights of above 1.00kg. NOTE, a herd of 25 suris.

You can select those animals, which are above 1.0 kgs and finer than 24 microns, or you can select those above the average for weight up to 24 microns. Of course there are many other traits to be considered, like fibre type, length, density, lustre etc.

**SUMMARY**

**DESIRABLE CHARACTERISTICS**

(Not in order)

- Lustre
- Fineness
- Density
- Lock formation (no crimp)
- Evenness of lock formation
- Coverage eg. Legs
  - Head
- Absence of guard hair

Suri locks should open freely and not be tangled or matted. In other words the integrity of the lock should be maintained.
Negative Fleece Traits

- Tender – weakness in staple
- Lack of uniformity of Fineness
- Lack of Lock Density
- Lack of coverage
- Brittle/coarse fibre
- Cotting (matting)
- Excessive guard hair
- Tip damage
- Suint stain
- Chalky fibre
- Short fibre (12 months growth)
- Suri – highly crimped

IDENTIFYING SUPERIOR SURI ALPACA FLEECE

Much is said about what a superior fleece should look like, and does it mean more money. Well the answer in my opinion is:

- An elite fleece will hopefully be lustrous, finer and softer due to its low C of V, denser and longer therefore having a greater fleece weight. Finer and more fleece weight = more money.

- Will the mills pay more money for excellence. Yes There is a given price based on micron and style and the overall return per fleece is subject to the total fleece weight.

So do we breed for the Average?

NO!! Definitely not. You should always select for excellence because in time that will be “the norm” and those with average fleece will be left behind.

So how do we recognise superior fleece. Look at all the characteristics and breed for the best of each characteristic.

- Lustre
- Acceptable fineness
- Softness (handle)
- Density of lock
- Good staple length over a 12 months growth period
- Lack of medullation
- Well nourished fibres
- Free flowing locks
SUPERIOR TO GOODStyled FLEECE

GOOD TWISTED RINGLET

SUPERIOR WAVE and TWISTED RINGLET

GOOD TIGHT TWISTED RINGLET

SUPERIOR CORKSCREW RINGLET

SUPERIOR -- LARGE WAVE
and BROAD LOCK -- good lustre

GOOD -- LARGE WAVE
and BROAD LOCK -- good lustre
AVERAGE TO POOR STYLE FLEECE

AVERAGE RINGLET
LACKING TWIST
SOME LUSTRE

AVERAGE RINGLET LACKING TWIST
and LUSTRE

PLAIN with some lustre

LARGE WAVE and BROAD LOCK
No lustre

NO STYLE OR LUSTRE
SUPPLY / DEMAND / END PRODUCTS

The total production of Alpaca fibre world wide (supply) and the demand from international fashion industries (demand) are the major factors in the final value of the Alpaca fibre in general.

Whilst supply is low and demand is maintained, a premium should always be available for this "fibre from the Gods". Breeders of alpaca fibre should keep in mind that the premium prices are normally paid for the finer fibre, suri fibre still commands a good price for medium /fine microned fibre.

Processors are now also looking for good styled suri fibre so as to maximise the softness and general behaviour of the fibre in the end product.

Products that help create demand could be,

**BRUSHED SURI CLOTH**
- WOMENS & MENS OVERCOATS
- BLAZERS & JACKETS
- RUGS
- WOVEN CLOTH

**FINE MICRON UNDER GARMENTS**

**HIGH FASHION FABRIC**
- DESIGNER CLOTHING
- LUXURY APPAREL, SWEATERS

**SPECIALTY FABRICS**
- INTERIOR
- TEXTILES

**Fibre diameter** – As mentioned earlier micron represents somewhere between 70% and 80% of the value of the fibre, and therefore has a big influence on the buyers’ price when calculating how much they will pay when purchasing the suri fleece fleece.
Graph shows the values per micron as well as yearly fluctuation.

Note the position suri holds with the other fibres.

The estimated percentage for micron is,
- 20 / 22.5 microns 20%
- 24.5 / 26 " 35%
- balance 45%

**Colour** - in the general fibre industry processors pay a premium for white fibre. This enables them to use pastel dyes and colours of their own choice. Some suri coloured fibre can also command a high price, but the premium is more likely to be found in the “cottage industries”. With current worldwide demand for natural fibres and natural colours it would seem appropriate to develop lines of “sort after” coloured alpaca suri fleece as well as white.

To get a perspective of **supply**, looking at the Peru production of alpaca fibres will help in seeing the overall global scene. South America has an estimated 3 million alpacas that are thought to represent 90% of the world’s population. Peru produces an estimated 3.5 million kilos of alpaca fibre. This would translate to suri fibre production of around 210000 to 350000 kilos.

Remember that suri is only around 6% / 10% of this production.
REFERENCES

Baychelier, Dr P  
Alpacas Australia Issue 39

Davison, I Dr & Holt, C.  
STUDY INTO COMPARATIVE DIFFERENCES OF  
SCIENTIFIC TESTING MACHINES USED  
IN ALPACA FIBRE MEASUREMENT  ( Report to A.A.A  2004)

Garnsworthy,R.(etal)  
Understanding the causes of prickle and itch from skin contact  

Haldene, R  
Private correspondence (1998)

Holt, C. & Stapleton I. Dr.  
A survey of ALPACA FLEECE CHARACTERISTICS, 1993 for AAA.  
Report Melbourne College of Textiles & LaTrobe University.

Holt, C.  
Advanced Alpaca Fibre Production ,  I.S.F.  2001

Holt, C  
Alpaca Appraisal and Selection.  I.S.F.  2001

Holt, C. & Scott, S,  
A Survey of Suri Fleece Characteristics,  1998

Maddocks I, etal  
Private correspondence (unpublished data) , 2004

Michell, D  
Peru  Private correspondence (2001)

Swan, Dr P  
Private correspondence

Tillman, A  
SURFACE SCANNING ELECTRON MICROSCOPY OF SURI ALPACA  
FIBER  Alpacas Magazine USA  2006

Uphill,G.  
Private correspondence,  CSIRO  2002

Watts,Dr.J.  
Elite Wool from Fibre to Fabric  

Watts,Dr.J.  
Private correspondence

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