Breeding Alpacas for the 21st Century

Experience has shown us that, of all the attributes of the alpaca, fleece quality continues to be the most significant determinant in show ring success. Years of breeding has shown the importance of effective selection criteria, measures that fast track us towards advanced fleeces that are exquisitely soft, silky and highly desirable, into a realm of alpaca, beyond what is known today and softer than cashmere.

This article summarizes the key points discussed at the inaugural Advanced Alpaca Fibre Production Workshop utilizing SRS® selection techniques held last November and hosted by Alpaka Appenzell in Switzerland. In presenting the workshop as the guest speaker, it was exciting to demonstrate the first small samples of SRS® style fleeces and animals in middle Europe for participants to examine and to discover 'fleece markers'. Progeny now are providing distinctive and considerably clearer examples for participants to examine in future workshops.

The Fleece Markers:

What are Fleece markers? What do they signify when breeding alpacas? What do they look like? To effectively understand the answers to these questions 'hands on' practical sessions, where touch and visual attributes can be identified, is paramount to the understanding of the SRS® Breeding system.

Let's have a look at these fleece markers:

Fleece marker	Follicle and fibre properties involved
Softness of handle	low fibre diameter uniform fibre size and shape smooth fibre surfaces
High crimp amplitude (deep crimp) & low crimp frequency (bold)	high fibre alignment long fibre low fibre diameter uniform fibre size and shape
Lustre	high fibre alignment uniform fibre size and shape smooth surfaced fibres
Long fibre bundles (highly aligned)	follicles closely packed within the follicle group and evenly seated in the skin. high fibre length high fibre alignment

Soft Handling wools; that seems clear enough as we have objective measurement tools such as histograms. W*ell aligned or bundling fibres* exhibit themselves as long thin matchstick like groups of fibres growing from the skin. Skin tests, carried out by Dr Jim Watts can give us an objective measurement of the density of these bundles and how they are growing from the skin. This then leaves *lustre and crimp*, both of which are clearly visible?

However, even if we can identify correctly each of the markers, the question now arises, how do we breed towards such wools? What is the implication of these traits in breeding?

The fleece markers indicate the genetic muscle that trigger major gene function that influence the quality and quantity of fleece an animal will grow. The aim of the SRS® breeding system is to select for high levels of fibre density and fibre length as the means of delivering high fleece weight and low fibre diameter as well as give improved processing performance. These these simple visual, as well as measurable, fleece markers are the paths to success.

The first of the fleece markers is soft handling wools. Can this be ascertained by the usual fleece testing procedures such as histogram or by visual and touch? Yes but only to a degree. What a histogram cannot pickup is the number of the primary fibres in a fleece and, the secondary fibres or their fibre diameter of these two different fibre populations. Given these two fibres, primary and secondary, respond quite differently to selection, it is important the breeders can identify the fibre problems in the fleece as well as the ones that are positive traits. Knowing what the primary fibre is doing is essential as it is highly inherited and can provide useful information to fast track your breeding programme, and conversely if not managed properly, to regress.

There are two types of wool follicles in the alpaca: primary follicles and secondary follicles.Primary fibres form most of the 'guard hair' seen in alpacas. Note in the diagram below the semi medullated and fully medullated primary fibres

Medullation is one of the major issues we encounter in the alpaca that has been carefully bred out of the more advanced fleece producing animals such as the merino sheep of Australia. In the alpaca primary fibres are more likely to be medullated than secondary fibres. This means that they are hollow fibres. When they are 100% medullated they are clear to the naked eye and often called guard hair, which in the wild, protects the soft 'down' or secondary fibres from the elements, i.e. wind, rain, snow, thorns etc. In alpacas there is also a high proportion of the secondary fibre that may also be medullated or partially medullated. Medullation starts creeping into the fibre when fibre diameter reaches approximately 20 micron. At 30-40 micron they are becoming fully medullated.

Medullated Fibre Types by J. Villarroel, 1959

A.Unbroken very wide (near to lattice type), 60 or more micron diameter
B. Unbroken medium wide, 40 – 60 micron diameter.
C. Interrupted, 30 – 40 micron diameter
D. Fragmented, 20 – 30 micron diameter
E. Non-medullated fibres, 15 – 20 micron diameter
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Medullation, given it's visual presence is unsightly on the animal and will not do well in a show ring, however it also has more serious implications. When wool is harvested from animals carrying medullated fibres, and put through processing machinery, it is the manufacturer's worst nightmare. Such fibres will snap causing tension problems, and extreme prickle factor in the finished garment causing customer dissatisfaction on purchase. Just as deleterious, medullated

fibres will not take up dye well, which means it is then impossible to utilize for high end garments as colours are unpredictable. The financial return on such wools is poor. Whilst different knitting techniques in hand crafted garments can disguise some of the negative traits garments made from such wools will not hold their shape well and lack lustre. They will also cause itchiness in the sensitive areas.

So, in the alpaca, with its duel population of primary fibres and secondary fibres, the aim is not to breed out primary fibres, as they are a biological necessity, but to reduce the diameter of these fibres and to decrease their micron to a level that is the same, or, as has been achieved with the merino sheep, to below that of the secondary fibres.

In Peru, a training session is in progress to remove the medullated fibres, an option that is not available to us for economic reasons.

All alpacas today, carry some medullated fibres. How much or how soft is that medullation? When you examine a fleece, feel its coarseness or softness. Some alpacas which are more advanced will still carry high populations of primary fibre but ask yourself the question, 'Are these course or relatively soft primary fibres? Are they spikey or do they still hold some crimp definition indicating they may not be completely hollow and rigid? You may in fact have an animal which has high density in their fleeces in both secondary and primary fibre populations but, that has a relatively low difference of micron between them. (And overall the whole fleece may still be soft) This is a much more useful animal to breed on with than say, a fleece exhibiting little medullation to the naked eye, but which has a very high differentiation of micron between the secondary fibres and the primaries. The fleece may be slow growing generally so the primary fibres maybe hidden inside the fleece so look carefully and see if you can feel and see those coarse, straight primaries. This is still a two coated animal despite its outward appearance. Additionally an animal that has a relatively high fibre diameter in its secondary population may have a low differentiation between the secondary and primary populations but in this case, many of the secondary population may also be partially or 100% medullated. This then reduces the overall genetic potential of that animal as it lacks one of the 4 fleece markers , that of 'softness of handle'.

Primary or secondary fibres that are medullated are difficult to see with the naked eye..

In summary, assistance to understand primary and secondary fibre is provided by SRS® Skintest analysis of your selected 'advanced' alpacas in your herd to qualify any mating decisions.

Remembering that the genetic regulation of primary and secondary fibre diameter is different.

Identifying alpacas with low primary fibre diameter will confirm your more 'advanced' alpacas and, as primary fibre is highly heritable, alpacas with poorer results will respond quickly to genetic selection.

Simultaneous with the pursuit of softness an SRS® alpaca seeks extra length and faster growing fibres, and density. Let's look at density, as unlike primary fibre, it is closely linked to fleece structure.

Let's look at the fleece markers again. As an aside, whilst all alpacas regardless of colour will respond quickly to selection when learning to identify fleece markers it is easier to put colour preference aside and look at the whites and fawns. Years of selective breeding driven by the consumer driven textile market i.e. Peru, shows higher levels of density, fleece structure and softness of handle. Notably more distinctive in these more advanced fleece types is crimp.

This raises the question, why is crimp important?

Recently in talking to our breeding consultant, Dr Jim Watts, he says ""Deep crimp (high crimp amplitude) is the outcome of high density, where the fibres are packed together and are highly aligned. . The internal structure of the Huacaya (and Merino) fibre from a deeply crimped animal is arranged as hemi-cylinders of orthocortex ('soft' keratin) and paracortex ('hard' keratin), creating balanced bending forces which allow the fibre to form a deep crimp arc and imbuing the fibre with high elasticity. The high content of orthocortex, the dye-accessible side of the fibre, contributes to the excellent dyeing results obtained with deeply crimped wools. Suri fibre has a different arrangement of orthocortex and paracortex which produces coiling, rather than crimping, of the fibre but the density-induced changes in fibre morphology are the same. In both cases, the staples are very thin and never thick or solid.

High crimp amplitude means that the fibres form deep crimp waves (vertical arrows)

Low crimp frequency means that there are few crimp waves per centimeter (horizontal arrows).

A wool fibre with deep crimp and low crimp frequency is long (fast growing) fibre

A wool fibre with shallow crimp and high crimp frequency is short (slow growing) fibre

As breeders we look into the show ring and often see high frequency crimping wools. These are only acceptable if our aim is to breed slow wool growing alpacas and are reflection of a selection tool, no longer relevant (and often a poor one) given the advent of micron measurement. Remember, advanced fleeced animals need to be commercially viable and commercial industries with their related research bodies such as the CSIRO in Australia, and specific wool studies from Universities in Australia and Peru, underpin our judges training... Judges increasingly are identifying animals that have highly productive wool output. Highly

productive, fast and long growing fleeces do not have high crimp frequency. When deep crimp is combined with bold crimp (low crimp frequency), the fibres are long (fast growing). Whilst overall fleece length is visually obvious, individual fibre length is not.

What is exciting for the alpaca breeder is that the potential for improvement is vast. Fibre length to fleece length ratio can vary from about 1.0 to 1.5 in Merino wools. The deeper the crimp is, the more likely this ratio is to be close to 1.5. High crimp amplitude is associated with high fibre elasticity and excellent drape in finished products. Whilst sheep have approximately 30% longer fibre length, than their fleece length, alpacas only have 11%, on average longer fibres than the fleece. Alpaca has considerable scope therefore for improvement.

Deep crimping wools which are high amplitude but low crimp frequency per centimetre grow longer wool in any given period of time than deep crimping wools with high frequency crimp over the same period. Measured by individual fibre length versus fleece length gives you a fibre/fleece length ratio. The higher this ratio the more it approaches the near 1.5 maximum that gives greater length of wool, greater fleece weight and leads to superior processing performance including better elasticity and drape in the end product.

The next article will explore the two fleece markers remaining, fibre bundling (high density and alignment) and lustre. It will describe how these attributes improve processing capabilities as well as are powerful selection tools to improve density, length, softness and overall beauty of the wool on alpacas. The articles will conclude with updated results of follicle development and other levels of improvement being experienced in herds in Australia. If there are any enquiries as to when the next breeding workshops will be held in Switzerland contact Nyree Wright or Markus Bischofberger at info@alpaka-appenzell.ch or the author, Janie Hicks at coolaroo@hinet.net.au or Jim Watts at srs@hinet.net.au.

A Freak of Nature?

Advanced alpacas bred for highly valuable wools have been the discussion of the past two articles written for Allespaca following Alpaka Appenzell's first Coolaroo Advance or Elite Fibre Production workshop based on SRS® principles held in last November in Switzerland.

Briefly, our aim is to increase the alpacas' genetic potential to lay down high numbers of follicles that produce fibres that are long growing, fast growing, fine in diameter and highly processable for textile manufacturing. SRS® principles are based on commercial production of viable fleece.

The last article looked at 2 of the 4 'fleece markers' and their significance, 'softness of handle' and 'deep, bold crimp'. Medulation, with its deleterious affect in our fleeces and its damaging role if we are aiming for high quality garments is related to the existence of high micron primary fibres in the alpaca fleeces. We discussed the importance of manipulating the micron of these primaries in our breeding programme and how this can be achieved. We discovered that deep crimp (high amplitude crimp) is the outcome of high density where fibres are packed together and highly aligned gives better processing performance including better elasticity and drape in the finished product. We looked briefly at what is a lock as against a bundle or matchstick like staple in our fleeces which leads us to look at the remaining fleece markers 'high alignment' and 'lustre', .

Before doing so, however there are a couple of issues that have come out of my recent experience showing Coolaroo and Alpaka Appenzell alpacas in Europe and, and working in the judging circuit in the United States.

Clearly, SRS® does not look at developing alpacas for showring or hobby purposes. However, as said previously, given wool production for commercial use, is at least 50 % of the criteria for an alpaca to do well in a ring under judges whose knowledge based is sourced from commercial industries so, it is of great benefit to know how to breed these 'advanced wools'.

In Australia, Coolaroo has adopted SRS® techniques since 1996. It has taken many years to begin to achieve the styles of processible wools and skin types that meet the demands of the textile industry and, we are still some distance away (in fact, generations away). Let me explain:

In merino sheep which is a highly developed annual harvest, an average sheep may cut 8 kilos of 18 micron wool that is even in diameter throughout the fleece and contains absolutely no prickle factor. It will not contain any fibres that are medulated. Not one.

By contrast, an adult alpaca may cut an average of 3 kilos of 23 micron wool that is highly variable in diameter throughout the fleece and contains ranges of at least 10-20 micron over the fleece and, <u>all</u> the primary fibres within that fleece will be 100% medulated.

Before you switch to a much less endearing animal, the merino sheep, have a better look at

this. It can be read in a highly positive light if you look at it from genetic potential. Even in today's primitive state, alpaca still competes with the elite raw products, like merino and cashmere (dehaired). Which, if you pause here to think about this, is very exciting. Let me explain. In 2001, we (my husband, Aldous and three children) moved to Peru to carry out a research project in conjunction with Dr Jim Watts. The aim was to ascertain the follicle density levels in the world's largest commercial herd of alpacas. The levels recorded from 1000's of animals examined from the leading Peruvian breeders from over 30 separate herds in the Alpaca breeding departments of Puno and Cuzco, including Accoyo, Alianza, Sollocotta, to name a few were examined. Approximately, the top 1 to 5% were skintested in each herd though some herds were not of density levels to meet skin testing criteria. We learnt that the variation between density levels was high as was the variation of measurements of secondary to primary follicle ratios, rate of growth per day, as well as micron diameter of the primary and secondary fibres. This indicates there is enormous genetic potential in the alpaca species to improve in today's population.

Further, we know that by adopting SRS® techniques, now showing exceptional results in sheep and angoras, and in the decade, alpacas, that genetic potential to improve is considerable.

A warning however for enthusiastic marketeers. May I caution here, that one does not become a breeder of any *advanced* alpacas over night. Patience is essential. Those claiming they breed or have SRS® alpacas anywhere in the world in a single generation, in an attempt to gain a marketing edge in the short term do SRS® no favours, nor themselves. It will indicate in time, their high level of ignorance as well as jeopardize the intregrity of the true science behind SRS®.

On the contrary, SRS® breeding, is dedication to close study of the technique by attending workshops, working with your SRS breeder and classers of your alpacas over generations. An advanced or SRS® alpaca is no freak of nature.

In the global natural textile industries, high end luxury products that are produced from the noble fibres of the world such as alpaca, merino wool and cashmere are sourced from countries such as Peru, Australia and China respectively, find their way onto the streets of Paris, London, Tokyo, New York and Beijing. These industries play a significant role and are major export commodities for these economies . Consequently they are underpinned by millions of dollars of investigative research by universities, government specialist research bodies, and agricultural societies. From this comes advanced breeding techniques such as the SRS® principles and experts in the field, such as Dr Jim Watts.

Whilst in its early development in Australia, with a herd of 100,000 alpacas as against an industry based on 87 million sheep, in order to be a viable export commodity in the not too distant future, the Australian Alpaca industry is going about developing global demand for their product by:

- using genetics to produce superior quality wools

- improving processing performance
- developing new innovative products
- developing new high-value technical markets.

Apparel, made from wool, alpaca and cashmere remain the most desired by consumers of high-end luxury products. Again, these natural raw wools do not come by a freak of nature. They are developed over generations of careful selection, by breeders and wool classers or consultants that assist the breeder, who listen carefully to the manufacturer to ensure the final textile has the attributes sort by the marketplace, to make luxury product.

- **Density can vary from about 15 to at least 90 wool follicles per square millimetre. The average is about 30.**
- **Fibre length, in terms of growth rate, can vary from about 0.20 to at least 0.60 millimetres per day. The average is about 0.30.**
- **If we doubled both the average density and length levels, the alpaca would change from producing about 3 kgs of 25 micron wool to one producing about 7.6 kgs of 20 micron wool, or 4.3 kgs of 15 micron wool.**